NATURE

No. 4476 SATURDAY, AUGUST 13, 1955 Vol. 176

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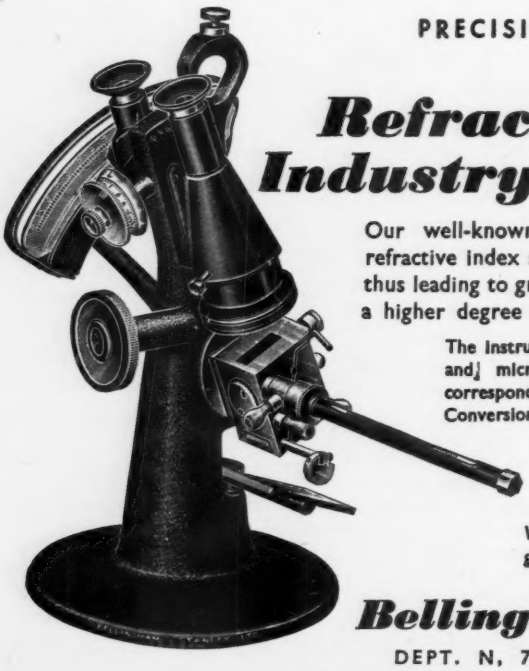

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NUCLEAR POWER AND ITS UTILIZATION

SINCE President Eisenhower first made his proposals, less than two years ago, for an international pool of atomic materials for peaceful purposes, optimism as to the immediate future of nuclear energy has steadily grown. Before the International Conference on the Peaceful Uses of Atomic Energy had opened at Geneva, Great Britain and the United States had given practical effect to their proposals for promoting internationally the constructive use of nuclear energy by making fissionable material available for use in nuclear research reactors overseas and by offering to train foreign scientists. On June 11 President Eisenhower, speaking at Pennsylvania State University, indicated that he proposed to extend this programme by asking Congress to agree to meet half the costs of building research reactors for free nations, including a supply of the necessary nuclear fuel, and to provide, within security considerations, information and experts to help friendly nations in the construction of full-scale power stations.

These proposals are of special interest to the underdeveloped countries, for President Eisenhower expressly contemplated support of the voluntary grouping of the resources of several nations within a single region, in order to acquire and operate together a research reactor which individually they lacked the technical or material resources to use effectively. They have also undoubtedly contributed to the more hopeful climate of opinion in which the Geneva Conference has met. Concerned essentially with the exchange of technical information and opinion on a wide range of subjects from piles and power plants, to the biological hazards of radioactive materials, the disposal of wastes and the uses of radioactive materials in industry, in medicine and in agriculture, its success or failure largely turns on the extent to which free discussion and exchange of views and information are unhindered by questions of secrecy. President Eisenhower's proposals in June gave encouraging evidence that this danger was remote and the potential spread of knowledge was unlikely to call into operation the restrictive clauses of the McMahon Act.

Not until the Conference concludes can it well be seen how far a more realistic and reasonable view of secrecy in nuclear science and technology has come to prevail. The Anglo-American agreements on nuclear energy, published shortly after President Eisenhower's statement in June, were disappointing and indicated that even between the United States and Great Britain we had still a long way to go before a full exchange and cross-fertilization of ideas in nuclear research was possible, and the overlapping of effort, particularly by scarce scientific man-power, reduced to an inescapable and justifiable minimum. There will indeed be a greater exchange of information on the effect of weapons on civil defence, on the generation of electric power, and on fissile materials; but, while it is still so difficult to separate the effort expended on nuclear research and development for peaceful purposes from that expended for military purposes, an agreement which provides for no co-ordination of fundamental research programmes and no exchange of information on the design and manufacture of nuclear weapons scarcely amounts to partnership.

Whether, in view of what the National Science Foundation has already reported as to the man-power situation, the United States can continue to afford the waste of man-power and technical resources thereby involved is their affair; but Great Britain at least can scarcely regard with indifference the loss of any opportunity of conserving her limited resources at a time when the demand upon them is still increasing. Since the publication in February of the White Paper outlining the Government's programme for the development of nuclear power in Great Britain, the Minister of Fuel and Power, Mr. Geoffrey Lloyd, has announced that six more nuclear reactors are to be built in Cumberland. These reactors, Mr. Geoffrey Lloyd said in the debate on the Queen's Speech on June 13, are additional to those proposed in the £300 million programme announced in February. They will be designed to produce both electric power and fissile material for military purposes, and will be of the same kind as those now being constructed at Calder Hall. The Minister also said that four main industrial groups have now been formed to develop this industry. They include Associated Electrical Industries – John Thompson; the English Electric – Babcock and Wilcox; the General Electric Company – Simon Carves; and C. A. Parsons – Head Wrightson – A. E. Reyrolle, registered recently as the Nuclear Power Plant Co.; and Foster Wheeler, Ltd., is engaged in research on the cooling of nuclear power reactors and has facilities for the design, manufacture and erection of equipment for reactor cooling. It should also be noted that the Institutions of Civil, Mechanical, Electrical and Chemical Engineers, together with the Institute of Physics, early in June constituted the British Nuclear Energy Conference as a permanent body, under the chairmanship of Sir Charles Hinton, for organizing meetings, symposia, the publication of papers, etc. This development was welcomed by the Minister, who also referred to the success of the training courses for engineers arranged by the Atomic Energy Authority. The new design organizations staffed by engineers so trained, he said, are already at work, producing ideas of their own and still in close touch with engineers of the Atomic Energy Authority.

This stepping up of the Government's plans, Mr. Geoffrey Lloyd told the House of Commons in the debate on the National Coal Board on July 20, will enable nuclear energy to contribute substantially to power production as from 1960. In that debate the Minister indeed proposed to meet the coal shortage by substituting oil for coal on a large scale during the next five years; but he gave no sound basis for the assumption that even the present output of coal can be maintained. It might well be sounder to

expand still further the programme for building nuclear stations. An expenditure of some £60 million on such stations would allow us to save about a quarter of the £80 million we are at present spending on the import of coal, apart from economies concerned with the production or plutonium and the possible reduction in capital investment in the railways, which carry most of the country's coal.

It is true that electrical engineers expressed the opinion at the British Electrical Power Convention that nuclear power is being developed faster than is technically desirable, and stressed the importance of examining means of getting adequate supplies of concentrated fissile materials for the advanced types of generating stations to be built in the later stages of the new nuclear programme. Despite the generous tributes paid to the work of the Atomic Energy Authority and the contracting firms associated with the developments, it was emphasized that the United States, in view of the different lines upon which production for military purposes is proceeding there, has a considerable potential advantage in the design and operation of the advanced types of nuclear generating plant contemplated in the British programme. Sir Claude Gibb in particular stressed this potential advantage possessed by electrical engineers in the United States, and it is clear that the Anglo-American agreements as well as the present international conference offer considerable advantages to Britain.

None the less, Britain's own contributions are important, though it is well to remember that, as Prof. W. R. Hawthorne remarked in an article in the *Westminster Bank Review* last May, we are not in such a stagnant period of scientific invention in respect of the older sources of power that we need inevitably depend on nuclear energy alone. In fact, nuclear energy is unlikely to ease the fuel position much in Britain in the next fifteen years, although the nuclear power programme offers savings of about five or six million tons of coal per annum by 1965. Sir Francis Simon, in an article in *Lloyds Bank Review* of April, regards the White Paper as a little too optimistic; he assumes that after a development period of fifteen to twenty years nuclear electricity will cost about the same as electricity from coal. To build up a nuclear power system equal to our present generating capacity will involve expenditure of about £3,000 million, and in view of other capital commitments such a system is unlikely to be complete in less than twenty to twenty-five years.

Sir Francis Simon thus thinks it will be about the middle of the next century before we can count on nuclear fission meeting most of the power requirements of Britain. Although he regards the use of nuclear power to drive large power stations of the same magnitude as those burning the conventional fuels as the first main application of nuclear energy—and stresses throughout this development the importance of saving coal by using it more efficiently—he points out that nuclear energy makes possible the provision of large or medium-sized power stations in out-of-the-way places, to which the transport of conventional fuels is either impossible or prohibitively expensive. This was also stressed by Dr. J. Bronowski in an article in the special ninetieth anniversary issue, entitled "Atoms for Peace", of the New York periodical, *The Nation*, dated June 18. Dr. Bronowski, in fact, regards the ability of the nuclear pile to offer concentrated power precisely where it is wanted in regions remote from either coal or water-power as the most important application of nuclear energy in large and thinly populated regions, like South Africa, which are rich in minerals. In the same journal, Prof. M. L. Oliphant makes much the same point in respect of the tropical and arid zones of Australia; but Sir Francis Simon goes on to show how important this possibility is to Britain. Under-developed centres are often under-developed because they have no power available, and he argues that the export of nuclear power stations is an ideal example of the kind of export on which Britain will have to depend increasingly. We are only at the very beginning of such developments. No nuclear power station has yet run under realistic conditions. Commercial generating stations based on the Calder Hall experiment may be begun by about 1957 and commence to operate in 1961; but although the Dounray power station is to be of the fast-breeder type, it is not anticipated that a commercial station of this design can be tested in operation before 1965. Many stations working on different principles will have to be built and tested before we know which is the most reliable and economic, and while international co-operation can facilitate the interchange of ideas between the best scientists and technologists in different countries, few countries can muster the necessary scientific and industrial resources to attack successfully such problems of development.

Sir Francis Simon considers that, for the time being, only the United States, Great Britain and the Soviet Union can be considered as serious competitors for the nuclear export market to under-developed countries, where the negligible weight of nuclear fuel offers possibilities in remote areas to which transport of coal or oil would be prohibitively expensive. He urges that there are strong incentives, political as well as economic, for getting a hold on this export market, but he stresses particularly the economic factor. The export of nuclear power stations is particularly suited to Great Britain. Apart from the British genius for science and technology which has already contributed to the present developments, Britain's economy is large enough to permit developments on the necessary scale. Even an increase in the power consumption of the non-industrialized countries to one-third of that of the present British consumption per head of population would require power stations worth twenty to thirty thousand million pounds, while in the long run the field is practically without limits.

Nor is this ideal and almost unlimited field for British enterprise the only possibility to be considered. Sir Francis does not answer the question whether the coming of nuclear power heralds a new industrial revolution, other than to suggest that by the middle of next century the world will probably derive most of its energy from nuclear sources, and that for the under-developed countries nuclear power will usher in a new era by enabling industry to be

established in places deprived of the conventional fuels. None the less, a resolution adopted by the Foreign Ministers of the Federal German Republic, Belgium, France, Italy, Luxembourg and The Netherlands at their meeting at Messina on June 1 and 2 assumes that the development of nuclear energy for peaceful purposes holds a prospect in the near future of a new industrial revolution out of all proportion to that which has taken place during the past hundred years. The six signatory States consider accordingly that it is necessary to study the creation of a common organization to be entrusted with the responsibility and the means for ensuring the peaceful development of nuclear energy, while taking into account the special arrangements made by certain Governments with third countries.

The means contemplated comprise the establishment of a common fund to provide for research and development; free access to raw materials and free exchange of techniques and technicians, by-products and specialized equipment; the pooling of results; and financial assistance in exploitation and co-operation with other countries. It seems clear from the Prime Minister's remarks, quoted by Sir Francis Simon, that the British Government is fully alive to the scope and potentialities of this entirely new export trade throughout the Commonwealth and Empire, and the possibilities of raising living standards in wide areas through nuclear power. Nevertheless, although he claimed that within two years the first power stations producing electricity would be working in this field, and that already many British firms are exploring markets overseas for their new products in this field, the reception given to the Messina resolution suggests that the opportunities in Europe are being overlooked.

The Messina resolution may, of course, prove to be one of good intention rather than firm resolve; but it offers something more than the European Organization for Nuclear Research which Britain is already supporting, and there are several reasons for anticipating prompt and fruitful action. The position of Germany of itself supplies a practical incentive for co-operation and integrated effort in Western Europe. Although Dr. Adenauer has disclaimed any intention of exploiting the military uses of nuclear energy or of making nuclear weapons, it is not to be expected that Western Germany, with its record in scientific research and development, will play no part in this new field of human endeavour now being opened up. Only by an integrated scheme in which all share the work, use the results and are aware of what is being done, can Germany participate without arousing the fears and jealousies of her neighbours.

It should also be remembered that in a new field like nuclear energy, there are no established interests to hinder development and demand reconciliation and adjustment. Great Britain, moreover, has a special interest in bringing about a Western European nuclear organization. The division of labour alone, at a time when on all sides we learn of the limitations which the shortage of scientific and technical skill places on the development of nuclear power, is itself a sufficient reason for Britain participating as actively in a communal European programme as in the European Organization for Nuclear Research at Geneva. There are also the sharing of benefits in development, the diffusion of prosperity in building up a gigantic new industry. The tributes paid by Sir Francis Simon and others to the great ability, enterprise and vision of the team which Britain possesses in the Atomic Energy Authority all reinforce the suggestion that the British Government would be wise to take the initiative and offer active assistance from the start in bringing such a nuclear community into existence.

The nature and degree of British participation and assistance are open to consideration and for definition in advance. They may well fall short of full participation, while providing the leadership and initiative that British technical achievements warrant; and the commitments must be carefully weighed, particularly in respect of the demand which they will make for trained scientific and technical man-power.

That demand requires evaluation with imagination and realism, keeping in mind the competitive demands for man-power made by other aspects of Britain's economy—including fuel, as Prof. Hawthorne indicated—and also considerations of economics and prestige. A bold grasp of the export opportunities for Britain in the field of nuclear energy would seem imperative. In regard to man-power, the uniformity with which the limitations due to shortage of skilled personnel has been reiterated is impressive. In his statement on June 13 in the debate on the Queen's Speech, Mr. Geoffrey Lloyd was emphatic that such limitations, rather than financial considerations, determine the pace at which the Government is expanding its programme, and on July 20 he said explicitly that progress depends upon the mental outlook of the scientists, engineers and designers with the necessary skill in this special sphere, who are numbered in hundreds rather than in the thousands required. This admission was taken up by Mr. Austen Albu in opening an adjournment debate in the House of Commons on scientific and technical man-power during the following day; but the same point was stressed both by Prof. Hawthorne and Sir Francis Simon. Prof. Hawthorne, while emphasizing the need for more technologists, gave a specific warning against sending too many able young engineers to Harwell for training in nuclear engineering lest the technological man-power available for other new developments be decreased excessively, although he admitted that advances in one branch of engineering stimulate advances in all the others.

Sir Francis Simon is no less emphatic as to the great need to increase the supply of men who are able to practise science and technology, either for the development of nuclear energy or any other form of energy. The key role in all these developments falls to scientists and technologists, and Sir Francis in his article in *Lloyds Bank Review* stresses particularly the importance of building up a sufficiently strong and balanced community of scientists and technologists. It is not enough for sufficient support to be provided for research in nuclear physics. Other fields of physics, chemistry and the engineering sciences are all equally important in the development of nuclear power; and quite apart from the im-

portance of other fields of technology to Britain's economy, the development of nuclear power is itself affected by our failure to provide adequately for road and rail transport development and to deal with the scientific and technical man-power situation with vision and imagination as well as with energy and adequate finance.

If the great opportunities which the development of nuclear power offers to Britain are to be used effectively, more will be required than what Mr. Lloyd described on June 13 as a 'shop window' at the Geneva Conference. The Government must give a positive lead, and make sure that, although the country is not in a position to offer nuclear fuel to the under-developed countries in the way that the United States can, the world is left in no doubt as to the value of the contribution in plant and technique which Britain can offer. Moreover, the absence of any such restricting legislation as the McMahon Act makes it easier for us to share our knowledge and experience than for the United States; and neither Europe nor the countries in the Colombo Plan should be left unaware of the benefits which Britain can bring them, or her advantage over the United States in this respect.

In all this, something of prestige is at stake, but much more also. For Britain to take full advantage of the possibilities for her economic future which nuclear energy offers, the Government must support the Atomic Energy Authority with a well-thought-out and comprehensive policy; it must be fully alive to what is involved in the way of educational policy and balanced scientific and technological development. It means tackling the problem of science teachers with energy and imagination. It means a programme for the expansion of technological and technical education, and keeping that expansion in balance with the expansion of university education. It means also close attention to secondary education, so that the supply of school leavers of the appropriate and broad education is to be forthcoming. It means attention to the nation's resources in scientific and technical research, and seeing that the development of natural resources as well as those of the public services is kept in balance.

Something of the challenge of the situation is to be glimpsed in Sir Francis Simon's article. Already Britain possesses in the Advisory Council on Scientific Policy and in other bodies much of the organization required. Some changes, however, may well be required, for example, in the responsibilities for university and technological and technical education, as between the Minister of Education, the Lord President of the Council and the University Grants Committee; and if the opportunities are to be used, there is much work to be done by the voluntary bodies. It can at least be hoped that the International Conference on the Peaceful Uses of Nuclear Energy will bring home to professional bodies generally the great opportunities which such developments hold for Britain's economic future, and that they will neglect no opportunity of securing the energetic and imaginative action which the prospect demands.

MAGNETODYNAMIC COSMOGONY

On the Origin of the Solar System

By Prof. H. Alfvén. (The International Series of Monographs on Physics.) Pp. vi+194. (Oxford: Clarendon Press; London: Oxford University Press, 1954.) 30*s*. net.

THE author is presenting here a new theory of the establishment and evolution of the solar system. He is well known for his contributions to electro- and magneto-dynamics, and he makes such processes play a major part here, too. The book is a very valuable source of suggestions of subtle processes that may be of relevance to this and other problems; and it serves to remind that a wide range of complicated electromagnetic effects may have to be understood for the solution of many astronomical problems. If the discussion is uncertain and speculative for including such effects, others are for leaving them out. No criticism should attach to that.

But if the work is to be regarded as a complete theory of the derivation of the solar system, and this is clearly what the author intends, then each one of the chain of processes or events would have to be shown to have at least a high degree of plausibility. This has not been accomplished. A major link in the chain concerns the separation by diffusion of the different constituents of a gas cloud. It is suggested that a large cloud (10^{17} cm.) is suspended against solar gravity by a magnetic field, and a very strong dipole moment of the early Sun is assumed. The gravitational force would then act on the non-ionized constituent, and this would diffuse inwards relative to the ionized component which would be magnetically held. Late in the book there is a brief mention of the importance of the linkage of the lines of force, stating that the lines of force necessary to support the gas against gravity must not link the cloud and the Sun. Indeed, this is a vital point, for a field of solar origin must inevitably link the Sun; it cannot then support the cloud but only slightly delay its infall by re-routing the material along longer paths. But the diffusive separation requires some 10^9 years and therefore a high stability of the configuration. It is hard to see why the solar field was introduced in that discussion. An alternative support is briefly mentioned; this is a magnetic field of interstellar clouds of gas. Such a field will not link the Sun, and could, if of adequate strength, give the desired support. But it can do so only if its lines of force are effectively anchored in gas far away and unaffected by the solar gravitation. But by linking the gas to interstellar material one is even further from any possibility of extreme stability with a motion of less than 10^{17} cm. in 10^9 years. The average velocities between stars and gas clouds are 10^4 or 10^5 times as high. Not only is the requirement not obtained in this way, but indeed it is hard to see how an extended gaseous mass surrounding the Sun could resist the interstellar streams, even if it is not magnetically connected to them.

There are other links in the chain of processes that one would like to see more fully discussed. The mechanism of transfer of angular momentum to a disk surrounding the Sun has long featured as a central problem in the subject; it may be that a magnetic interaction with the Sun is responsible, but the process will have to be understood, and the limit of its effectiveness evaluated. THOMAS GOLD

THE STATISTICS OF CHANGE

An Introduction to Stochastic Processes, with Special Reference to Methods and Applications

By Prof. M. S. Bartlett. Pp. xiv+312. (Cambridge: At the University Press, 1955.) 35*s*. net.

THE theory of stochastic processes is the mathematics of systems which change in accordance with probability laws. There are many applications—for example, to the study of epidemics, cosmic ray showers, irregularities in textile processing, queueing and storage problems, the growth and mutation of bacterial populations, and communication theory. Prof. M. S. Bartlett has made distinguished contributions to many branches of the theory, and now he has produced this masterly introduction to the whole field. He writes as a statistician and applied mathematician and is therefore thoroughly justified in avoiding detailed discussion of various matters, which, while of considerable mathematical interest, can easily divert attention from the aspects of most importance in applications. The result is that he has been able to cover concisely a remarkable range of methods and problems and that, while the book is highly mathematical, the mathematics is always directed towards obtaining a working answer to the problems under discussion. The pure mathematical aspects of stochastic processes have been dealt with in a recent book by J. L. Doob; the point of view of the two books is entirely different, and Prof. Bartlett's is the only one at present available for the more applied worker in this field.

After a preliminary chapter devoted to basic definitions and to recalling some results in probability theory, there is a chapter on random walks and Markov chains occurring in 'discrete time'; one of the applications described is to the statistical mechanics of nearest-neighbour systems. There is next a chapter on the corresponding processes in continuous time. Particularly noteworthy here is the discussion of passage and recurrence time problems, based on an elegant symbolism for determining the Laplace transforms, or probability generating functions, of the distributions of the times taken for specified types of transition to occur. This section of the book is completed by a long chapter on miscellaneous applications. The topics discussed here include population growth and epidemic models.

The next group of chapters deals with stationary processes, that is, systems which are in statistical equilibrium. After a preliminary chapter, there is an account of the spectral function and of the generalized harmonic analysis of stationary processes. This is followed by a discussion of recurrence times and, among other things, a brief account of applications to the theory of turbulence. The third chapter of this group deals with prediction and communication theory.

The final two chapters discuss problems of statistical inference connected with stochastic processes, the last chapter being about the correlation and spectral analysis of stationary time-series. This gathers together in a valuable way recent work on this subject. The emphasis is on situations where the object of the statistical analysis is to examine the structure of the observed process. It would have been interesting to have had also some discussion of other applications, for example, to problems of sampling, where the precise structure of the process is not the point at issue. It might also have been helpful to have had some mention of processes which, while stationary, show appreciably greater long-term fluctuations than processes usually considered in the theory. An example is when the spectral density behaves like $\omega^{-\alpha}$, $0 < \alpha < 1$ as ω tends to zero. This seems to happen in some applications, for example, in certain textile problems where there are sources of random irregularities with very long wave-lengths.

The presentation is open to minor criticism. In detail the writing, though clear, is very concise, and the book is not easy reading. Some familiarity seems desirable with the elementary parts of the subject (such as those given in the book by W. Feller); results for simple processes are almost always obtained as special cases of general formulæ, rather than used for preliminary illustration of the ideas involved, as would, perhaps, have been advisable in an introductory work. Also, the assumptions for special applications are occasionally set out only in symbolic form. This will cause no difficulty to anyone reading the book systematically, but is hard on the reader who wishes just to find out what is assumed in the discussion of some particular application of interest. However, the book is a characteristically original, impressive and important contribution to the subject, and deserves to be widely read. D. R. Cox

MEASUREMENT AND AUTOMATIC CONTROL

Instrument Engineering

(McGraw-Hill Publications in Aeronautical Science.) By Charles Stark Draper, Prof. Walter McKay and Prof. Sidney Lees. Vol. 1: Methods for Describing the Situations of Instrument Engineering. Pp. xvi+269; 51*s*. Vol. 2: Methods for Associating Mathematical Solutions with Common Forms. Pp. xxviii+827; 120*s*.
(London: McGraw-Hill Publishing Company, Ltd., 1952, 1953.)

THESE volumes are out of the ordinary, both in magnitude and in presentation of the subject-matter. They are the first two of three volumes—the third is not yet available—which combine the functions of introductory text-book and comprehensive reference book of mathematical techniques relating to "the art and science by which the properties of matter and the laws of nature are made useful to man in the observation and control of physical processes".

The authors are members of the Aeronautical Engineering Department of the Massachusetts Institute of Technology, and these books are the outcome of twenty years experience in research and postgraduate teaching in the field of aircraft instrumentation and control. This background has largely influenced the presentation of the subject-matter, and made possible the accumulation of the very large number of most useful results of mathematical analysis which are now made more widely available.

The need to find a common language and symbolism for mathematicians, physicists and a diversity of engineers—aeronautical, electrical and mechanical—in a field to which all have combined to contribute has led the authors to devise an elaborate, but most carefully defined, nomenclature and symbolism, which are used throughout the volumes. This leads, however, to such distressingly cumbersome statements as: ". . . it appears that, from the standpoint

of physical fact, the *i^{th} to k^{th} actuating input function product–reference input function product performance function ratio function* reduces to the ratio of the reference input function product to the i^{th} to k^{th} input function product" (Vol. 1, p. 134). Even the corresponding mathematical statement is little shorter, because of the use of "self-defining symbols" in the statement of general relations. A simple example is sufficient to indicate their form and use: the standard deviation of x is given by $(SD)x \equiv (RMS)\,[(D)\,x]$, in which $(D)x \equiv x - (Av)x$ (Vol. 1, p. 148). The authors, of course, accept the use of "working variable symbols" in deriving results, but consider that all results other than those derived for purely educational purposes should be formulated finally in terms of "self-defining symbols" (Vol. 1, p. 109), and they conform rigidly to this practice.

When the reader has overcome the initial difficulties of interpretation—the difficulties of translation even from American to English terminology (for example, fitting constant (FC) ≡ constant of integration) give one especial sympathy for the non-English-speaking reader—there are available in these volumes a most thorough exposition of a rigorously systematized way of analysing physical systems mathematically (Vol. 1), and analytical, graphical and numerical methods for deriving the solutions of the resulting differential equations, with—perhaps the most valuable feature of the work to the British engineer—nearly two hundred clearly reproduced large-scale graphs presenting data concerning every aspect of these solutions (Vol. 2). There are, also, in Vol. 1 useful introductions to dimensional analysis and statistical methods, and in Vol. 2 a chapter on the analysis of second-order discontinuous systems, having "non-linear terms of the rate-determined step type", due, for example, to the effect of Coulomb friction or of relay-operated controlling devices.

To sum up, these volumes are most welcome publications, in making generally available the very thorough exposition and useful graphs which have previously only been available locally. Because of the language and notation it seems unlikely that they will be considered suitable for teaching purposes on the eastern side of the Atlantic, but as reference books they are likely to prove of lasting value and should be available in every library of books on instrumentation and control engineering.

G. D. S. MacLellan

MAMMALIAN BIOCHEMISTRY

Principles of Biochemistry

By Prof. Abraham White, Prof. Philip Handler, Prof. Emil L. Smith and Dr. DeWitt Stetten. Pp. xiii + 1117. (London: McGraw-Hill Publishing Company, Ltd., 1954.) 112*s.* 6*d.*

THIS book is described on the dust-cover as "an integrated presentation of fundamentals". It might at first sight be doubted whether, with four authors at work, much integration could be achieved; but in fact they have succeeded so well that it is worth mentioning how they went about writing the book. The first draft of each chapter was assigned to one of the four authors and, when completed, was criticized by the other three. They met regularly for such discussions for several days at a time, and in some instances a chapter written by one of them was rewritten by another. In the end, each author had contributed to each chapter. As a result, this book shows none of the overlapping or lack of continuity of style or matter which is so often found in a book by several authors.

The subject is treated in seven sections which deal in turn with the chemical composition of the cells, the enzymes, intermediary metabolism, the body fluids, specialized tissues, the hormones and nutrition. Intermediary metabolism is introduced by a valuable chapter on the general methods used in investigating metabolism—experiments on whole animals, on isolated organs and on tissue preparations, the study of patients with inborn errors of metabolism, the use of isotopes as tracers, and so on. The last section, nutrition, is at first sight surprisingly brief for a book of this size; but clearly so many topics bearing on nutrition have already been covered earlier in the book—vitamin A under the lipids and under the biochemistry of the eye, various members of the vitamin B complex under individual coenzymes, and so on—that there is correspondingly less remaining to be dealt with in the nutrition section. All the same, a chapter of one and a half pages on chemical elements in nutrition does seem almost ludicrously short. This tendency towards the curtailing of topics considered under nutrition will presumably continue as more and more becomes known of the precise biochemical function of the vitamins. In books on theoretical biochemistry, the vitamins will tend to be dealt with separately in connexion with the metabolic reactions which they influence rather than as a heterogeneous group of organic compounds which the body needs but cannot make. But the vitamins are closely linked by the early history of their discovery and investigation, and it will be a great pity if in the text-books this history gets lost sight of in a mass of details of chemical reactions and specific catalysts.

The style of writing throughout the book is scholarly and clear, and it is evident that the authors are writing from a wide experience of teaching. The book is well produced, with the structural formulæ and chemical equations admirably set out. There are occasional slips or misprints (for example, in the structural formulæ of the nucleosides and nucleotides on pp. 186–188, where the groups attached to the sugar rings should all be inverted), but these are few and far between. The book relies largely for its figures on reproductions from published work, and on the whole these have not been adequately assimilated into the text. For explanation of the figures the reader is almost entirely dependent on the smaller-print legends; these are sometimes of almost telegraphic brevity, and it would have made for easier reading if there had been a little more comment on the figures in the main part of the text.

While the book is mainly on mammalian biochemistry, it deals to some extent with comparative biochemistry, and there are frequent references to the biochemistry of micro-organisms and plants. For example, the chapter on carbohydrate metabolism begins, very reasonably, with an outline of the processes of photosynthesis. The references at the ends of the chapters, many of them to books and review articles, are well chosen, up to date and by no means confined to American publications. For undergraduate medical students, in any event in Britain, this book will probably be considered too large and too costly. For science students and for those engaged in teaching and research, it will be welcomed as a stimulating and a well-written text-book.

D. C. Harrison

CURARE ALKALOIDS*

By Prof. P. KARRER, For.Mem.R.S.
Chemical Institute, University of Zurich

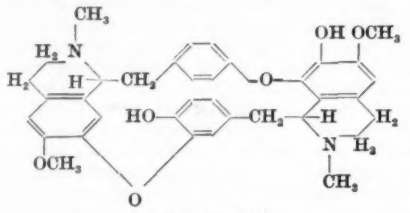
ARROW poisons have been known for centuries and have been used in certain regions of Africa, Asia, South America and also Europe. The African and Asiatic poisons are almost exclusively of a glucoside nature. In certain Asiatic countries the commonest and most important arrow poison is made from the latex of *Antiaris toxifera*, a member of the Moraceae, which contains the glucosides α- and β-antiarine; in Africa it is very often made from one of the Apocynaceae, *Acokanthera*, the toxic principle of which is the glucoside ouabain. In Europe, from prehistoric times until about the fifteenth century, it is possible that extracts of species of aconite, *Veratrum album*, snake poisons, etc., were used as arrow poisons. The toxic principle of the South American arrow poisons is alkaloids; this poison is called curare and its alkaloids curare alkaloids.

Three different kinds of South American curare are known: pot-curare, tubocurare and calabash curare. They not only differ in their containers (unglazed clay pots, bamboo tubes and calabashes or gourds), but also in the nature of their active principles and in their toxicity. The calabash curare is by far the most toxic, and therefore the most desirable one but also the most difficult one to obtain.

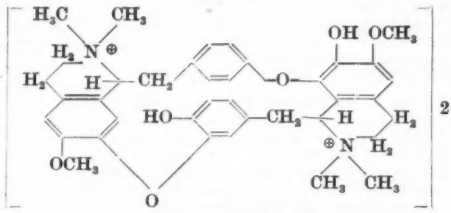
Wintersteiner introduced *d*-tubocurarine in medicine and it is still the only natural curare alkaloid used for clinical purposes. Its commercial name is 'Intocostrine'. The activity and toxicity of *d*-tubocurarine appear to be low compared with those of certain calabash alkaloids.

The most important and most active South American arrow poison, the calabash curare, has for the frog a toxicity of 0·5–1 mgm. per kgm. The first chemical work on this arrow poison dates back to the pharmacologist Böhm. However, it was not until 1937–41 that H. Wieland and his co-workers were able to isolate for the first time some pure alkaloids in a crystalline form.

The calabash curare usually contains a very great number of different alkaloids. In a sample originating from the Rio Negro region, we were able to demonstrate by paper chromatograms the occurrence of more than thirty different bases. For distinguishing the different spots on the paper chromatograms, we have used the colour reactions with ceric sulphate, which gives with the different alkaloids, red, blue, yellow, green, purple or yellowish-green colours. Furthermore, colour tests with cinnamic aldehyde, nitric acid and sulphuric acid have been made, as has also an examination of the fluorescence shown by some of these alkaloids under ultra-violet light.



l-Curine (I)



d-Tubocurarine (II)

The investigations which my colleagues and I have carried out in recent years in Zurich on curare alkaloids concern almost exclusively those obtained from calabash curare and *Strychnos* barks. Since the time of Alexander v. Humbolt, it has been known that the natives of South America used for the preparation of calabash curare especially barks of several *Strychnos* species (for example, *S. toxifera, gubleri, castelnai, rubiginosa, hirsuta, yapurensis, triplinervia, curare baillon*, etc.). A number of other plants, which are admixed when curare is prepared (*Cocculus* species, Menispermaceae, Araceae, Euphorbiaceae), seem to contribute nothing or very little to the toxicity of the poison.

From tubocurare and pot-curare some di-*iso*-chinoline-alkaloids have been isolated which have the character of di-tertiary bases or di-quaternary salts. Examples are *l*-curine (= *l*-bebeerine) and *d*-tubocurarine; the first has the character of a tertiary base, the latter is a di-quaternary di-*iso*-chinolinium-salt. For the preparation of tubocurare, and pot-curare probably especially, *Chondrodendrum* species are used, in the barks of which in some cases the same alkaloids occur as those found in the above-mentioned kinds of curare.

The quantitative separation of the mixtures of the bases was carried out in our laboratory by partition paper-chromatograms of their chlorides. For this purpose very long columns of paper-powder and long development-times are necessary. It took more than a year to separate twenty-three alkaloids of the above-mentioned mixture in pure crystalline form. The chemical composition of these substances is very similar, as can be seen from the following formulæ:

		R_c*
C-alkaloid *A*	$C_{37}H_{42}O_6N_2^+$	0·23
C-alkaloid *B*	$C_{37}H_{42}ON_2^+$	0·34
C-alkaloid *C*	?	0·34
C-alkaloid *D*	$C_{37}H_{41}ON_2^+$	0·35
C-alkaloid *E*	$C_{19}H_{23}ON_2^+$	0·36
C-toxiferine *I*	$C_{20}H_{21}N_2^+$	0·42
C-alkaloid *F*	$C_{36}H_{42}O_6N_2^+$	0·49
C-alkaloid *G*	$C_{19}H_{23}ON_2^+$	0·65
C-alkaloid *H*	?	0·71
C-calebassine	$C_{19}H_{23}ON_2^+$	0·80
C-alkaloid *I*	$C_{19}H_{25-29}N_2^+$	0·89
C-curarine	$C_{20}H_{21}N_2^+$	1·00
C-alkaloid *J*	$C_{19}H_{21}N_2^+$	1·04
C-dihydro-toxiferine	$C_{20}H_{23}N_2^+$	1·22
C-alkaloid *UB*	$C_{19}H_{23}O_2N_2^+$	—
C-alkaloid *M*	?	1·45
C-calebass-inine	$C_{17}H_{19}O_2N_2^+$	1·68
C-fluorocurine	$C_{20}H_{23}O_2N_2^+$	2·10
C-fluoro-curinine	$C_{21}H_{25}O_2N_2^+$	2·23
C-fluoro-curarine	$C_{20}H_{23}ON_2^+$	2·25
C-alkaloid *L*	?	2·50
C-mavacurine	$C_{20}H_{23}ON_2^+$	2·70

* R_c = distance travelled by the alkaloid / distance travelled by curarine

Solvent = methyl ethyl ketone saturated with water + 1–3 per cent methanol

* Substance of two lectures delivered in the University of London (School of Pharmacy) on March 10 and 11.

From calabashes of different origin we were able to isolate other new alkaloids, and also from barks of several *Strychnos* species (*mitscherlichii, toxifera, melinoniana*) new bases of this group have been obtained; most of them have the character of quaternary salts, but some are tertiary bases. Up to date, the following pure calabash- and *Strychnos*-bark alkaloids are known:

* + C-curarine I (refs. 2, 8, 9, 10)
* C-curarine II (ref. 3) (C-strychnotoxine Iα) (ref. 11)
* + C-curarine III = C-fluorocurarine (refs. 3, 8, 9, 10)
* + C-toxiferine I = toxiferine I (refs. 1, 4, 6, 8, 9, 17)
* + C-toxiferine II = C-calebassine (refs. 4, 5, 8, 9, 10, 17) (= C-strychnotoxine I)
* + toxiferine II (ref. 4) (= strychnotoxine II (ref. 11)
* C-dihydrotoxiferine I = C-alkaloid *K* (refs. 4, 8, 9)
* C-*iso*dihydrotoxiferine (ref. 4)
* + C-alkaloid *A* (refs. 5, 8, 9, 10)
* + C-alkaloid *B* (refs. 5, 8, 9, 10)
* + C-alkaloid *C* (refs. 8, 9, 10)
* C-alkaloid *D* (refs. 8, 9)
* C-alkaloid *E* (refs. 8, 9)
* C-alkaloid *F* (refs. 8, 9)
* C-alkaloid *G* (refs. 8, 9)
* C-alkaloid *H* (refs. 8, 9)
* C-alkaloid *J* (refs. 8, 9)
* C-alkaloid *L* (refs. 8, 9)
* C-alkaloid *M* (ref. 13)
* C-alkaloid *O* (ref. 12)
* C-alkaloid *P* (ref. 12)
* C-alkaloid *UB* (refs. 7, 8, 9)
* + C-alkaloid *Y* (refs. 5, 13)
* C-alkaloid *X* (refs. 7, 8, 9)
* C-calebassinine (refs. 8, 9)
* + C-fluorocurine (refs. 8, 9 14)
* + C-fluorocurinine (refs. 8, 9, 10)
* + C-mavacurine (refs. 11, 14)
* C-xanthocurine (ref. 12)
* + C-guaianin (ref. 12)
* + C-alkaloid I (refs. 8, 9, 10)
* C-alkaloid 1 (ref. 11)
* C-alkaloid 2 (ref. 11)
+ fedamazine (ref. 14)
+ caracurine I (ref. 14)
+ caracurine II (ref. 14)
+ caracurine III (ref. 14)
+ caracurine IV (ref. 14)
+ caracurine V (ref. 14)
+ caracurine VI (ref. 14)
+ caracurine VII (ref. 14)
+ caracurine VIII (ref. 15)
+ caracurine IX (ref. 15)
+ nordihydrotoxiferine (ref. 15)
+ melinonine *A* (ref. 16) (= tetrahydroalstonine-chlormethylate)
+ melinonine *B* (ref. 16)
+ "toxiferines III to XII" of H. King (ref. 17) (homogeneousness not proved)

* = alkaloids found in calabashes.
\+ = alkaloids found in barks of *Strychnos* species.

[1] Wieland, H., Konz, W., and Sonderhoff, R., *Ann.*, **527**, 160 (1937).
[2] Wieland, H., and Pistor, H. J., *Ann.*, **536**, 68 (1938).
[3] Wieland, H., Pistor, H. J., and Bähr, K., *Ann.*, **547**, 140 (1941).
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[9] Kebrle, J., Schmid, H., Waser, P., and Karrer, P., *Helv. Chim. Acta*, **36**, 102 (1953).
[10] Kebrle, J., Schmid, H., Waser, P., and Karrer, P., *Helv. Chim. Acta*, **36**, 345 (1953).
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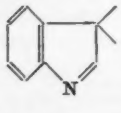
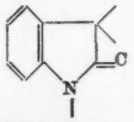
[12] Giesbrecht, E., Meyer, H., Bächli, E., Schmid, H., and Karrer, P., *Helv. Chim. Acta*, **37**, 1974 (1954).
[13] Asmis, H., Bächli, E., Giesbrecht, E., Kebrle, J., Schmid, H., and Karrer, P., *Helv. Chim. Acta*, **37**, 1968 (1954).
[14] Asmis, H., Schmid, H., and Karrer, P., *Helv. Chim. Acta*, **37**, 1983 (1954).
[15] Asmis, H., Schmid, H., and Karrer, P. (unpublished).
[16] Schlittler, E., and Hohl, J., *Helv. Chim. Acta*, **35**, 29 (1952).
[17] King, H., *J. Chem. Soc.*, 3265 (1949).

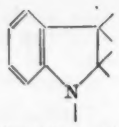
The ultra-violet spectra of the calabash- and *Strychnos*-bark alkaloids show that most of these compounds are indole derivatives. It is possible to divide them into about eight groups, which probably possess the following chromophores:



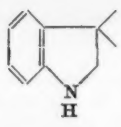
C-Curarine
C-Alkaloids *G* and *E*
C-Guaianine
Caracurine V



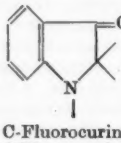
C-Toxiferine
C-Dihydrotoxiferine
C-Alkaloids *H* and 2
Caracurine VI



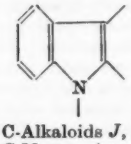
C-Alkaloids *A*, *F*
I, II, X, Y
Caracurine IV and VII (?)



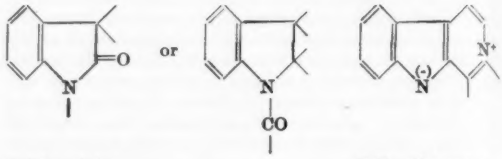
C-Alkaloids *B*, *C*, *D*
Caracurine II and III



C-Fluorocurine
C-Fluorocurinine



C-Alkaloids *J*, *L*, I
C-Mavacurine
Toxiferine III
Melinonine *B*



Calebassinine
C-Alkaloids *UB* and *M*

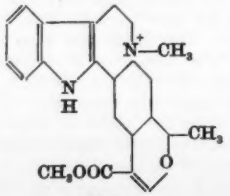
C-Xanthocurine
Fedamazine

The elucidation of the constitution of the calabash and *Strychnos* bark alkaloids is an objective which still lies in a rather distant future. Some first degradation experiments on calabash alkaloids were conducted by Wieland and his co-workers. By dehydration reactions on dihydrotoxiferine I, they succeeded in obtaining β-ethylindole and *iso*chinoline, whereas from C-toxiferine II some β-ethylpyridine was obtained; they suggested the presence of *iso*-chinoline—or chinoline—or indole-rings in C-curarine.

We were able to get by distillation with zinc dust from C-norcurarine, which itself had been obtained by thermal decomposition of the quaternary chloride of C-curarine I, β-ethylpyridine, β-ethylindole, skatole, carbazole and *l*-methylcarbazole.

The production of β-ethylindole after distillation with zinc dust of norcurarin makes it probable that C-curarine is, like many other plant bases, derived from tryptamine. The isolation of carbazole and *l*-methylcarbazole, however, excludes a constitution based upon the harman type (yohimbine bases). The dehydrogenation products obtained indicate the relationship of C-curarine with the *Strychnos* alkaloids. Thus strychnine, on vigorous degradation, gave β-ethylindole, β-collidine and carbazole.

An alkaloid melinonine *A* (III), which E. Schlittler discovered in the bark of *Strychnos melinoniana* and which is without curare activity, has proved to be the chlormethylate of tetrahydroalstonine, an indole alkaloid the constitution of which was already known:

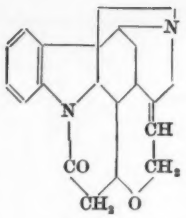


(III)

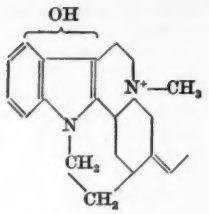
A thorough investigation of the two calabash alkaloids fluorocurine and mavacurine in our laboratory showed that between these two compounds, which always occur together, interesting connexions exist and it was possible to get an insight into their structure.

The indoxyl derivative fluorocurine can be reduced by sodium borohydride to hydrofluorocurine, and the latter is easily transformed by acids into the indole derivative mavacurine. We have followed many degradation reactions which have enabled us to clear up the constitution of these three alkaloids, with the exception of the position of one OH-group which occurs in these compounds.

Hydrofluorocurine (V) readily undergoes the so-called Emde degradation; that is, when subjected to reduction with platinum and hydrogen in alcoholic solution, a carbon atom attached to the quaternary nitrogen atom is split off; at the same time, hydrogenation of the C=C double bond of hydrofluorocurine takes place. On degradation with chromic acid, the Emde base (VII) gave a methyl-ethyl-acetic acid (IX); this proves that the position of the side chain of the hydrofluorocurine relative to the N(b)-atom of the compound corresponds to formula (V). The Emde degradation of mavacurine (VI) leads to a substance of the constitution (VIII), an indole



Strychnine

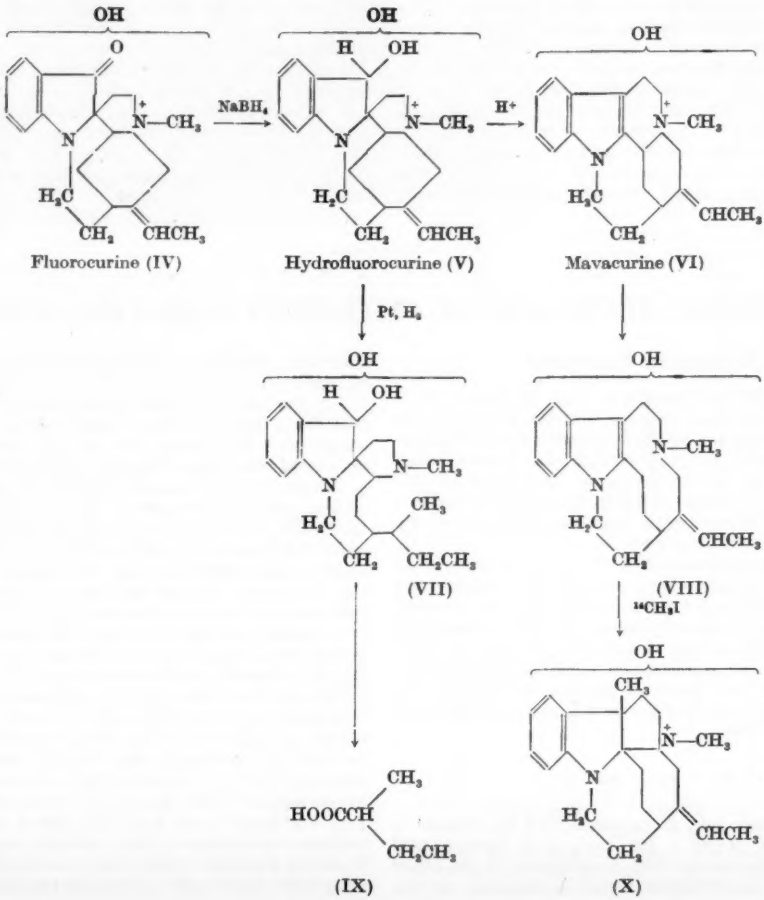


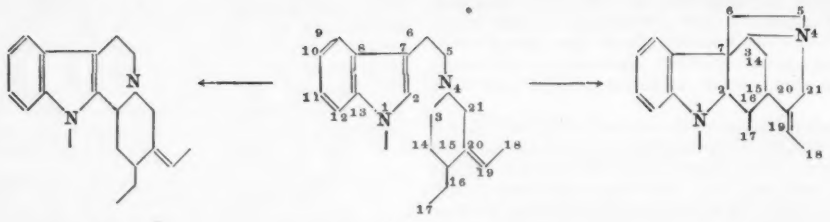
Mavacurine

derivative, which could be methylated by methyl-^{14}C iodide to an indoline derivative (X) containing a CH_3-group on the carbon atom 3. A number of other reactions of fluorocurine and mavacurine agree with the formulæ IV and VI proposed for these two alkaloids.

It is a remarkable fact that the carbon double bond which occurs in fluorocurine and mavacurine has the same position with regard to the N(b)-nitrogen atom of the two alkaloids as that in strychnine to the corresponding N(b)-atom.

Already Sir Robert Robinson and R. B. Woodward have pointed to possible genetic relationships between the yohimbine and strychnine alkaloids. If in the





(B) (A) (C)

hypothetical substance *A* a bond between the two carbon atoms 2 and 3 is formed, a compound *B* of the β-carboline or yohimbine type arises. But if in substance *A* the carbon atoms 3 and 7 on one side and the carbon atoms 2 and 16 on the other side are connected by bonds, a compound *C* of the strychnine type would be formed. Further investigations will show if type *C* is also realized among the curare alkaloids.

Formulæ *B* and *C* show very clearly the identical position of the carbon double bond in mavacurine and fluorocurine on one hand and of strychnine on the other.

During recent years compounds with curare activity have aroused great medical interest; they find practical application in surgery during anæsthesia, causing complete relaxation of the muscle, thereby enabling the quantity of the anæsthetic to be reduced. For practical purposes *d*-tubocurarine ('Intocostrine') especially is used, and to a limited extent also synthetic compounds. For many of these synthetic substances the formula of *d*-tubocurarine, which contains two quaternary ammonium salt groups, served as a model. But the halogen alkylates of strychnidine and dihydrostrychnidine which have been investigated in our laboratory contain, like the calabash alkaloids, only one quaternary ammonium salt group and are about as toxic and as active as 'Intocostrine'. I have already mentioned that some calabash alkaloids, for example C-curarine, are probably related to strychnine with regard to their constitution. It is true that the curare activity of the halogen alkylates of strychnidine is about a hundred times less than that of C-curarine and about three hundred times smaller than that of the calabash alkaloid C-toxiferine I.

With their lethal doses of about 1–8γ per kgm. for mice, the calabash alkaloids *F* and *G* belong to the most toxic substances which are known to-day. 1 gm. of these compounds would paralyse at least a hundred tons of mice.

A group of colleagues and pupils of mine participated in the investigations on calabash curare; I mention particularly Prof. H. Schmid, who took part in these investigations from their beginning, and Dr. P. Waser, Dr. A. Ebnöther, Dr. J. Kebrle, Dr. H. Asmis, Dr. H. Bickel, Miss Bächli and H. Meyer.

AN ATOMIC STANDARD OF FREQUENCY AND TIME INTERVAL

A Cæsium Resonator

A FREQUENCY standard (Fig. 1) based on a natural resonant frequency of the cæsium atom has been constructed at the National Physical Laboratory and used for calibrating the quartz clock standards with an accuracy of ± 1 part in 10^9 (0·0001 sec. per day). It makes use of the atomic beam magnetic resonance technique developed by Rabi and his collaborators[1].

The resonance observed is that due to transitions between the hyperfine structure energy-levels caused by the interaction between the nuclear and electron spins. For observational purposes a uniform magnetic field is applied so that these energy-levels are split into their Zeeman components. The frequency of the central line of the Zeeman pattern is, however, to the first order, independent of the value of the field, being given by[2,3]

$$\nu = \nu_0 + 427\,H^2,$$

where H is the field in oersteds and ν_0, which is approximately $9\,192 \times 10^6$ c./s., is a fundamental constant of the atom. The frequencies of the other lines have a much larger, linear dependence on the field and provide a convenient means of defining its effective value.

All the allowed transitions have been observed, and from measurements made under a variety of conditions the frequency of the central line at zero field was found to be 9 192 631 830 ± 10 c./s. in terms of the present adopted frequency of the quartz standard, which is based on a provisional uniform time-scale[4] estimated by the Royal Greenwich Observatory. The sharpness of the resonance is indicated in Fig. 2, which is typical of the resonance curves we have obtained. As, in practice, the observations are made in the presence of a small uniform field, it may be convenient to define the standard as the frequency of the central line at a specified field. We propose to use the value obtained when the field is adjusted to make the frequency of the adjacent (3·1–4·1) line exactly 500 kc./s. higher than that of the central line because, by such a procedure, the difficult measurement of effective field is replaced by a simple frequency measurement. The frequency of the central line for this condition is 9 192 632 050 ± 10 c./s. The potential precision of the cæsium standard at the National Physical Laboratory is considerably higher than the 1 part in 10^9 at present claimed; but special

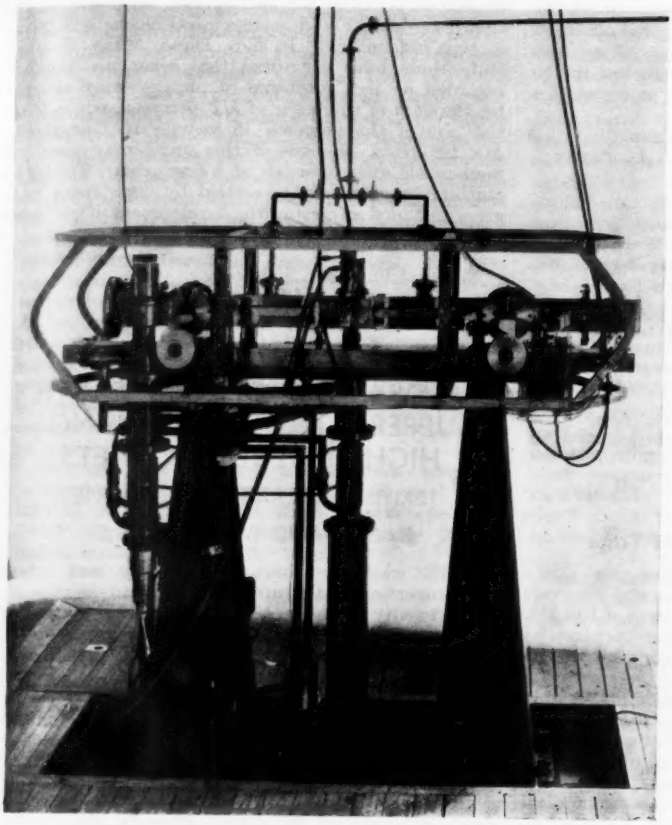


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Fig. 1. The atomic beam chamber supported on two pedestals, the oil diffusion pumps, and the coils for producing the appropriate d.c. field. The radio-frequency field for exciting the resonance is applied to two cavity resonators, which are coupled to an oscillator by means of the waveguide feeds on the top of the beam chamber

electronic techniques will have to be developed before this higher precision can be utilized. The accuracy given is that which has already been achieved and which can be used with our existing quartz standards and techniques of frequency measurement[5,6].

The apparatus is designed to enable many of the parameters to be varied through a wide range so that any effect of such variations on the observed resonant frequencies can be studied. When the permissible tolerances have been determined, a simpler model can be designed. During this investigation the apparatus will be used for periodic checks on the frequency of the quartz clock which constitutes our working standard of frequency and time-interval. A comparison between these results and the values derived from the unit of Universal Time should give interesting information concerning the variations of the period of rotation of the Earth, which are known to be of the order of 1 part in 10^8 and which at present limit the accuracy of frequency standardization. It has been suggested that Ephemeris Time[7], which is based on the sidereal year, should be used for eliminating the variations in the length of the day. The unit of time in this system can be given with the required precision only some years in retrospect, although it is hoped[8] by means of observations of the Moon at a number of observatories to reduce this delay to one year. Whatever system is used, an astronomical unit of time accurate to 1 part in 10^9 will be at least one year in arrears and will, of course, be an average value over that period. The great advantage of an atomic standard is that it enables the frequency standardization to be effected by measurements lasting only a few minutes. The value thus determined can be made available throughout a large area of the world by means of standard frequency transmissions[9,10].

The pioneer work on atomic standards of frequency has been carried out in the United States, and before starting this work one of the authors had many helpful discussions, in particular with Dr. H. Lyons and Profs. P. Kusch, C. H. Townes and J. R. Zacharias. Lyons[3] built a cæsium standard at the National Bureau of Standards, Washington, D.C., and obtained a value of 9 192·632 Mc./s. for the frequency of the central line. Later he has used the Ramsey method of excitation, as used in this experiment, giving a much sharper resonance, but has not published any results so far as we are aware. More recently, Zacharias, Yates and Haun[11] have described a somewhat different cæsium beam apparatus, and Townes[12] has described an oscillator based on a transition in the ammonia molecule; but in neither case are absolute values of frequency given. The results reported here appear, therefore, to be the

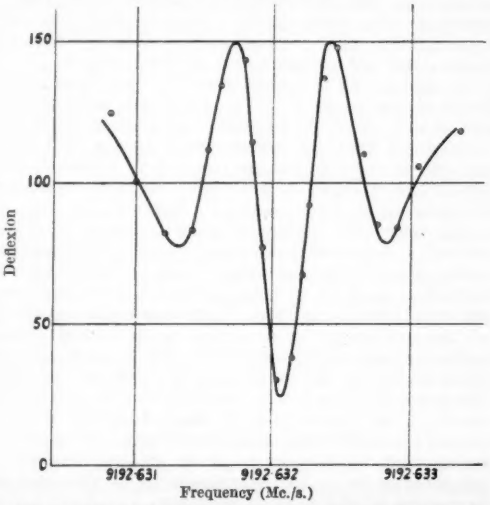

Fig. 2. Plot of the 3·0–4·0 transition in cæsium. Zero on the meter deflexion is arbitrary, the resonance dip being about ½ of the total beam current

first examples of the use of an atomic frequency standard with an accuracy greater than that obtained by using a unit of astronomical time. They also represent the highest accuracy ever achieved in the measurement of any physical quantity in terms of a definitive standard.

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J. V. L. Parry

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National Physical Laboratory,
Teddington, Middlesex.
June 11.

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[12] Townes, C. H., *Proc. Inst. Radio Eng.*, **43**, No. 3, 364 (1955).

Definition of the Second of Time

The preceding communication by Essen and Parry describes a means by which frequencies and intervals of time may be measured with an accuracy of 1 in 10^9, and holds out a prospect of even higher accuracies.

Ephemeris Time, on which the definition of the second adopted by the International Astronomical Union and the International Committee of Weights and Measures depends, is derived from the motion of the Moon. If the position of the Moon at any time can be determined to 0·05 sec., a period of four years would be necessary to obtain an accuracy of 1 in 10^9 in time and frequency derived from astronomical observation. Essen and Parry mention Markowitz's proposals for reducing this period to one year; these depend on a reduction of the errors by repetition of observations. Such a reduction would involve a study of systematic errors in star places and in the corrections for differential refraction that would certainly take many years. During this time the atomic clocks will be improved, probably by a greater factor than the astronomical determinations.

It thus seems probable that for the foreseeable future the accuracy of the measurement of frequency and of time intervals relative to laboratory standards will exceed that by astronomical means, and that the astronomically defined second is therefore incapable of realization with the accuracy necessary for microwave spectroscopy. The natural way of escape from this difficulty is to define a 'physical second' in terms of the natural period of the cæsium atom, choosing the numerical value so that it agrees as well as may be with the current estimates of the second of Ephemeris Time. Experience of the working of the machinery for obtaining international agreement on such matters suggests that some years are likely to elapse before a decision could be reached. The purpose of the present communication is to solicit views on the desirability of abandoning the astronomical second for the most refined physical measurements and to encourage other suitably equipped laboratories to make determinations of the cæsium frequency of the highest accuracy.

It is possible that the new accuracy in the measurement of frequency will reveal some unexpected phenomena. It is not self-evident that the times shown by atomic and astronomical clocks will keep in step indefinitely. In fact, Dirac, Milne, Jordan and others have suggested that what are usually regarded as the 'constants of physics' may change by amounts of the order of $1/T$ per year, where T is the 'age of the universe' in years. If T is about 4×10^9 years, changes of this order may soon be measurable over intervals of a few years. This is a matter that can only be settled by experiment and gives an added interest to the development of methods of precise time-keeping.

E. C. Bullard

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June 16.

EXPLORATION OF THE EARTH'S UPPER ATMOSPHERE USING HIGH-ALTITUDE ROCKETS

BRITISH RESEARCH PROGRAMME

By Sir DAVID BRUNT, Sec.R.S.

THE wind, temperature, humidity and other properties of the atmosphere up to heights of about twenty miles can be studied directly by means of instruments carried up by free balloons. Observations of this kind are regularly made by meteorological services throughout the world. Although the atmosphere at greater heights is very tenuous, it necessarily plays an important part in many phenomena. Thus long-distance radio propagation is only possible because of the existence of reflecting layers, the ionosphere, at altitudes of 60 miles and above—indeed, a very important region extends upwards from a height of 90 miles. Meteors are mainly evaporated at the 60-mile level, and the aurora, at least in high latitudes, is located at about the same level. The electric currents which give rise to the variations of the earth's magnetic field circulate in this region, and it is also the seat of a night-time air-glow quite distinct from the aurora or the light of moon and stars.

Before the Second World War, information about the upper atmosphere could only be obtained by indirect methods. The remarkable developments of rockets as weapons led to the possibility of carrying instruments into the upper air in vehicles of this kind. This was first achieved in the United States in 1946, using captured V2 rockets. Since that time steady progress has been made and many interesting results have been obtained. The greatest height reached so far has been 240 miles.

A research programme of this kind is expensive, and until recently was exclusively carried out by American scientists and technicians. It is very desirable that work should be carried out in other countries, to obtain data under different conditions and locations and employing different techniques. A programme has already been commenced in France, and an extensive programme is now being initiated in the United Kingdom through the co-operation of the Ministry of Supply, particularly the Royal Aircraft Establishment, and the Gassiot Committee of the Royal Society. The programme aims at having available, within two years, rockets able to carry 100 lb. weight of scientific instruments up to heights

of 120 miles or more. The design, development, supply and firing of the rockets will be carried out by the Ministry of Supply. Five university research groups, from University College, London (Prof. H. S. W. Massey), the University of Birmingham (Prof. J. Sayers), The Queen's University of Belfast (Profs. D. R. Bates and K. G. Emeléus), University College, Swansea (Dr. W. J. G. Beynon) and the Imperial College of Science and Technology, London (Prof. P. A. Sheppard), will be initial participants in the scientific programme. The work will be co-ordinated through a special sub-committee of the Gassiot Committee of the Royal Society. The first experiments will include determination of atmospheric temperature and density, the study of the nature of the ionosphere, a search for very fine meteoric dust below 60 miles altitude, and determination of the heights of the regions from which the night air-glow is strongest. While the development of the rockets is proceeding, work on the scientific instruments required will proceed in parallel, so that both should be available at nearly the same time.

Although this programme has been arranged independently of the International Geophysical Year, 1957–58, it is hoped that it will be in operation during this period and add substantially to the British contribution to the Year.

OBITUARIES

Sir Harold Tempany, C.M.G., C.B.E.

Sir Harold Tempany's forty-three years in the Colonial Agricultural Service (now called the Agricultural Branch of H.M. Oversea Civil Service) stretched a good way on either side of the great changes which followed on the Imperial Agricultural Conference of 1927. These gave the Service the beginnings of a unity, enlarged it in numbers and resources, provided training for its cadets and placed at its head an agricultural adviser to the Secretary of State for the Colonies. The late Sir Frank Stockdale was the first to fill this post (1929). Tempany joined him as assistant adviser in 1936 and, succeeding him in 1940, was in office during the hard years up to his retirement in 1946.

Variety in the earlier half of his career gave width to the knowledge of climates, soils, agriculture and administration on which his success in the diversified tasks of the latter half depended. Soon after graduating at University College, London, where chemistry, always central in his technical thinking, was his main study, he was appointed assistant agricultural chemist, Leeward Islands, in 1903, and a few years later chief chemist and superintendent of agriculture. In Mauritius during 1917–29, as director of agriculture, he was also responsible for the co-operative credit societies, and became the first principal of its College of Agriculture and a member of its Council of Government. Malaya was his next Colony. While director of agriculture for seven years from 1929, he put new life into the investigation of the food crops and livestock of its peasant farming, formerly overshadowed by its great export crop, rubber. The training of local assistants and general agricultural education also profited greatly from his interest.

By 1940, when Tempany became agricultural adviser in the Colonial Office, Stockdale had put new spirit into the whole Colonial Agricultural Service and made the Colonial Advisory Council for Agriculture, Animal Health and Forestry an influential body, warm in support of his exertions. Soil erosion throughout the Colonial Territories was, at last, being checked; the basic importance of the peasant economy had become recognized; specialist research had begun to be intelligently related to major problems; and study of husbandry and farming systems to be effectively promoted. Further, it was accepted that agricultural development in a territory could not spring from unconcerted pushing of individual commodities but required a policy based on primary physical and ethnic considerations.

In 1940 Tempany, who in his four years as assistant adviser had had a hand in all these developments, became, as adviser, responsible for doing what was possible to carry them on while also wrestling with the acute war-time food-supply problems of all the Colonial territories.

The Colonial Development and Welfare Act, 1940, greatly enlarged the funds for research, and a committee of the Colonial Advisory Council for Agriculture, Animal Health and Forestry was set up to report on research organization in those subjects. In its prolonged, arduous, discussions it fell to Tempany, particularly, to maintain free scope for technical agriculture and science, while conceding a due authority to administrative control. The present Colonial Agricultural Research Committee was set up, conformably with the recommendations, and the idea of a regional basis for research was also adopted. In 1946, a commission of three, under Tempany, visited East Africa for the conference at which initial arrangements for an East African regional organization were drawn up.

At formal meetings, Tempany's conscientious marshalling of facts sometimes tended to irritate his less-patient colleagues who, none the less, respected his tenacity and his high aims for the Service. It was in travel and when dealing with problems out on the land that he was seen at his best. But, indoors or out, he was unfailingly industrious, conscientious, fair-minded and kindly.

Tempany had periods of service on the board of governors of the Imperial Institute, the governing body of the Imperial College of Tropical Agriculture, the Sudan Government London Scientific Advisory Committee on Agricultural Research, the Chemical Council and the Council of the Royal Institute of Chemistry, and in 1950 he received a silver medal of the Royal Society of Arts. Most of his writing went into official papers: he published "Principles of Tropical Agriculture" (1930: with G. E. Mann); "The Practice of Soil Conservation in the British Colonial Empire" (1949); and "Agriculture in the West Indies" (1942). Leisure for writing, for which he longed, and happy opportunity, came in 1946 when, on retiring, he became editor of *World Crops*.

In 1911 he married Annie Frances Agnes, eldest daughter of Robert Goodwin, of Antigua, who died in 1945; their son died, in Nairobi, only two days before the death of his father in London on July 2. His second marriage, in 1946, was to Kate, youngest daughter of William Welfare. F. L. Engledow

Prof. R. H. A. Plimmer

The distinguished biochemist and one of the founders of the Biochemical Society, Robert Henry Aders Plimmer, emeritus professor of chemistry in the University of London, died on June 18 at the age of seventy-eight.

At the time of his death, Prof. Plimmer was a member of the staff of the Department of Biochemistry at the British Postgraduate Medical School, Hammersmith.

Born on April 25, 1877, the eldest son of Alfred Aders, of Manchester, he adopted the name of his stepfather, Henry George Plimmer, F.R.S., an eminent bacteriologist who undoubtedly influenced him in his choice of a scientific career. He was educated at Dulwich College, University College, and in Geneva and Berlin, and obtained his D.Sc. (London) in 1902 and worked in the Lister Institute for two years as a Grocers' Company research student. In 1904 he returned to University College as an assistant in the Department of Physiological Chemistry, his first teaching post. He was to remain at University College for fifteen fruitful years, during which time he became assistant professor and finally reader in physiological chemistry. He was elected a Fellow of the College in 1906. Together with Bayliss and Starling, he helped to plan and equip the new Physiology School, and he reorganized the teaching of physiological chemistry. His well-known text-book, "Organic and Bio-chemistry", dates from this time, as does the valuable series of "Monographs on Biochemistry", of which he was co-editor with Hopkins, and to which he contributed "The Chemical Constitution of the Proteins". Protein analysis, which he had studied in Emil Fischer's laboratory at Berlin, became one of his main lines of research, and he was long regarded as a leading authority on this subject.

Biochemistry was just beginning to be recognized as a subject in its own right, and the time appeared to be ripe for the formation of a club or society with the object of encouraging closer co-operation among workers in this field. The lead was taken by Plimmer and J. A. Gardner. They called a meeting at University College in January 1911, which led to the founding of the Biochemical Society with Plimmer as its first secretary; Gardner became treasurer in 1913. The present flourishing, vigorous Society owes much to the initiative and foresight of these two co-founders, who steered it through its difficult early days. Plimmer was made an honorary member in 1943 and later wrote the "History of the Biochemical Society" up to the time of the First International Congress of Biochemistry held at Cambridge in 1949.

During the First World War, Plimmer was attached to the R.A.M.C. and worked for a time at the Army Medical College, Millbank. He was commissioned to assay the energy values of the common foodstuffs—a task which entailed many thousands of analyses. The results of this work were later published by H.M. Stationery Office.

In 1919 Plimmer was appointed head of the Biochemistry Department at the Rowett Institute for Research in Animal Nutrition, Aberdeen. His old school friend, John Q. Rowett, had generously contributed towards the founding of this Institute, and had also financed the last Antarctic expedition of Sir Ernest Shackleton, another old Dulwich College boy. But Plimmer was not happy away from London and, when the opportunity came, he applied for the chair in chemistry at St. Thomas's Hospital Medical School, London, the post he was destined to occupy with distinction for twenty-one years—from January 1922 until December 1942.

At St. Thomas's Plimmer found congenial colleagues and facilities for research. He was a successful teacher, beloved by his students, to whom he gave every encouragement while exercising strict discipline. His lectures on inorganic and organic chemistry, biochemistry, toxicology, and the Nightingale Lectures in elementary science for nurses, were models of lucidity. Full of energy and drive, he carried out an astonishing amount of research on the nutritive values of foods and their relative vitamin contents. Plimmer's poultry farm on the roof of his department was a source of great interest and, incidentally, many a delicious meal for his colleagues. He was an advocate of the 'balanced diet', and, together with his wife, wrote several popular books on food values. "Food, Health, Vitamins", written by Prof. and Mrs. Plimmer, ran through nine editions and contained their famous 'square meal' chart.

Plimmer loved hard work at his laboratory bench; but he also thoroughly enjoyed his leisure hours at home with his wife and family. Always a keen motorist, he toured extensively on the Continent with his family during vacation. He enjoyed watching first-class cricket, loved good music, frequently visited Glyndebourne, and was an ideal host.

On the outbreak of war in 1939, teaching continued at St. Thomas's until the Hospital was severely damaged by bombs in September 1940. The staff and students then moved to the Manor House, Godalming, and were permitted to use the laboratories in the nearby Charterhouse School. While at Godalming, Plimmer reached the age of sixty-five and retired from St. Thomas's in December 1942. He was too full of energy to remain idle for long, and he gladly accepted Prof. E. J. King's invitation to work in the Biochemistry Department of the British Postgraduate Medical School, Hammersmith. Greatly beloved by all his colleagues, he continued actively working there from January 1943 until the end of his life.

The death of his wife in July 1949 was a great blow to him; but he was comforted by the presence of his eldest daughter and her family, who lived with him until a few months before his death.

John Lowndes

Prof. Gustave Magnel

The death of Prof. Gustave Magnel on July 5 deprives civil engineering of one of its leading figures. Prof. Magnel had a world-wide reputation as the originator of the Magnel–Blaton system of prestressing concrete, according to which the prestressing wires are formed into a cable of rectangular section by means of spacer grilles, and are anchored by steel wedges hammered into 'sandwich plates'.

Gustave Paul Robert Magnel was born at Esschen in the province of Antwerp in 1889, and graduated in civil engineering in the University of Ghent in 1912. His early working years were spent in England where, during the First World War, he worked as assistant, and later chief engineer, for the firm of D. G. Somerville and Co., of London.

After the War he returned to Ghent, and to his old University, where he became professor of structures and reinforced concrete, and director of the concrete laboratory. Between the Wars he became one of the earliest enthusiasts for prestressed concrete; it was during the Second World War that he developed his own system of prestressing. The system did much to widen the scope of the new and revolutionary technique of prestressing, and has been used in many different countries for bridges, buildings and circular structures such as tanks and silos. Prof. Magnel himself designed most of the early structures

prestressed by his system—as a consulting engineer he had an international reputation.

As a university professor, Magnel was acknowledged to be outstanding. His lectures were remarkable for their clarity of exposition, and the same quality marked his writings. His numerous technical books are standard text-books; they cover a wide range of subjects, and contain an unusual wealth of practical detail. Chief among his published works are: "Pratique du Calcul du Béton Armé" in four volumes, of which Volume 4 is "Le Béton Précontraint", "Cours de Stabilité des Constructions" in four volumes—the complete University course in structures—and "Le Calcul pratique des Poutres Vierendeel". "Le Béton Précontraint" has been translated into English, and published in Great Britain. He was also the author of numerous papers in French and English (in a paper given before the Institution of Civil Engineers in 1949 he introduced the Magnel–Blaton system of prestressing to Britain), and he initiated the publication of the bilingual periodical *Précontrainte–Prestressing*.

As a lecturer, Prof. Magnel was well known in the United States and in South Africa, as well as in Britain, his perfect command of English no less than his command of his subject always ensuring him an appreciative audience. Wherever he went he was an outspoken crusader for high-quality concrete and was forthright in his condemnation of slipshod workmanship.

Prof. Magnel had been honoured both in Great Britain and in the United States as well as in Belgium. A member of the Belgian Royal Academy, he was elected a member of the Institution of Structural Engineers in 1934, and of the Institution of Civil Engineers in 1950. He was also a member of the American Society of Civil Engineers and the American Concrete Institute, and a holder of the American Frank P. Brown Medal. He was chairman of the Belgian Prestressed Concrete Group, and senior vice-president of the International Federation of Prestressing. In this capacity his keen intellect, sound judgment and always unruffled courtesy, as well as his genius for smooth organization, will be sadly missed at the forthcoming International Congress at Amsterdam. His dynamic, yet always kindly, personality will be missed by all who knew him.

BETTY CAMPBELL

NEWS and VIEWS

Chemistry at the Imperial College, London: Prof. E. A. R. Braude

IN taking up the appointment of professor of organic chemistry at the Imperial College of Science and Technology, London, Dr. E. A. R. Braude follows a distinguished line starting with Hofmann and continuing to recent times through Frankland, Armstrong, Tilden, Thorpe and Heilbron. South Kensington has been celebrated not only as a centre of research in the subject but also as a training ground for students, from the time of Perkins, father and son, onwards. In the appointment of Dr. Braude the College has selected one of the leading young British organic chemists, who has a wide and important range of interests; at the same time, it has secured the services of one deeply experienced in the special educational methods associated with this school. Dr. Braude was born in 1922. After a distinguished undergraduate career at the Imperial College, he continued there as a postgraduate research student under Sir Ian Heilbron. He was awarded the Ph.D. degree in 1945. He was appointed assistant lecturer in 1946, lecturer in 1947, and reader in organic chemistry in 1952. He was awarded the Meldola Medal of the Royal Institute of Chemistry for 1950, and received the D.Sc. degree in the same year. He is a member of the Council of the Chemical Society.

Prof. G. Wilkinson

THE chair of inorganic chemistry in the University of London tenable at the Imperial College of Science and Technology, from which Prof. H. V. A. Briscoe retired last year, has been filled by the appointment of Dr. G. Wilkinson, who graduated there as a Royal Scholar in 1941 and was elected Frank Hatton prizeman. Dr. Wilkinson then undertook research in inorganic chemistry at the College until, in 1943, he was appointed to a research post in the joint British–Canadian–United States atomic energy project, serving for three years at Montreal and at Chalk River. After the War, he was a research associate, engaged in Prof. G. T. Seaborg's laboratory in the University of California, on investigations of radioisotopes leading to quantitative studies of the reaction of high-energy protons with the heavier elements; he later held a similar post in Prof. C. D. Coryell's laboratory at the Massachusetts Institute of Technology, working on the conditions of formation of complexes by phosphorus halides. Since 1951, as assistant professor of chemistry at Harvard University, he has been directing a research group studying, *inter alia*, the properties of bis-*cyclo*pentadienyl compounds of the transitional elements, and in association with Prof. R. B. Woodward and others has been responsible for considerable progress in this new field of chemistry. Last year Prof. Wilkinson, as John Simon Guggenheim Fellow, spent some months in Prof. J. Bjerrum's laboratory at Copenhagen. By his delight in experimental investigation, his experience as a lecturer on inorganic and nuclear chemistry, and his administrative services as secretary to the Department of Chemistry at Harvard, he will take to the Imperial College enthusiasm for the development of studies in modern aspects of inorganic chemistry and wide knowledge of the facilities now available for that purpose.

Physics at King's College, London: Prof. W. C. Price

HIS many friends on both sides of the Atlantic will be pleased to know that the title of professor of physics in the University of London has been conferred on Dr. W. C. Price in respect of his appointment at King's College. Dr. Price has held the post of reader in experimental physics in the College for several years, and is well known as a spectroscopist who has worked mainly on the structure of polyatomic molecules, both in the vacuum ultra-violet and in the infra-red spectral regions. He was the first to show that the short-wave spectra of a large number of basic molecules, such as acetylene, ethylene, benzene, water, the alkyl halides, etc., can

be interpreted as a succession of electronic transitions which converge to limits corresponding to the photo-ionization of particular electrons within the molecule. This phase of Dr. Price's work was started while he was a Commonwealth Fellow at the Johns Hopkins University during 1932–35 and developed later at Cambridge, where he was on the staff of the Physical Chemistry Department and held a fellowship of Trinity College.

During the later years of the Second World War, Dr. Price became attached to Imperial Chemical Industries, Ltd. (Billingham Division), where he applied infra-red techniques to industrial problems, particularly those concerned with the war effort. During 1946–47 he was research associate at the Molecular Spectroscopy Laboratory in the University of Chicago, and in 1949 he took up his appointment at King's College, London. His contributions in infra-red spectroscopy include the experimental evidence for the bridge structure of diborane and its metal derivatives, the elucidation of the nature of the vibrations of the peptide link, the theory of infra-red reflexion spectra from molecular crystals, and high-resolution studies of emission spectra of molecules and radicals. Dr. Price has during the past few years contributed greatly to the teaching duties and administration of the Physics Department at King's College.

Ford Prize for Peaceful Uses of Atomic Energy

On the opening day of the Geneva Conference on the Peaceful Uses of Atomic Energy, it was announced by the Ford Motor Co. that it will put aside one million dollars to provide an annual prize for the best contribution to the subject. The award is to be made by an international jury, and the honorarium of 75,000 dollars and a medal may go to an individual or a group of scientists, irrespective of race or political views. If no award is made, the money is to be used for providing fellowships for scientists likely to contribute to the advancement of the peaceful application of atomic energy. This munificent gesture is a response, the Company states, to President Eisenhower's appeal to industry to offer an incentive in finding new ways of using atomic energy for the benefit of the human race, and has been made by Mr. Henry Ford and his brothers as a memorial to their father.

New Reactor at Harwell

A full-scale, very low-power model of the Dounreay fast reactor has been built at Harwell and should be in operation before the end of this year. It has been named ZEUS (Zero Energy Uranium System) and will provide data relating to the design and operation of the Dounreay experimental plant. ZEUS is a fast reactor like ZEPHYR (the Zero Energy Fast Reactor), and the reacting core contains only the fuel, its canning material, and the coolant; there is no moderating material such as heavy water or graphite to slow down the neutrons. The fuel is uranium highly enriched in uranium-235 (from the diffusion plant at Capenhurst), instead of the plutonium fuel used in ZEPHYR. The fuel is in the form of long tubes which are mounted vertically to form a hexagonal-shaped core. The core is surrounded by an envelope of natural uranium, the purpose of which is to absorb the neutrons from the core and so produce plutonium. The Dounreay reactor and ZEUS are both breeder reactors in the sense that the amount of plutonium produced in the reactor should exceed the amount of uranium-235 burned in the core. It is not expected that the breeding margin will be as high as it was in ZEPHYR, where the amount of fresh plutonium produced in the reactor was found to be about double the amount consumed in the core. The operating power-level of ZEUS will be only about one-millionth of that of the proposed Dounreay reactor. This will be sufficient for experimental studies. Because of the complex technical problems which they pose, fast reactors will not play a prominent part in the early stages of the utilization of atomic energy; but when they do come into widespread use they will make it possible for a substantial supply of fissile material to be obtained economically from a relatively modest supply of uranium.

Radio-astronomy at Cambridge

The University of Cambridge has accepted the offer of a gift by Mullards, Ltd., of ten annual subscriptions of £10,000 each, for continuing and extending the work in radio-astronomy which is now being carried out at the Cavendish Laboratory. It is intended to set up a new observatory on a site near Cambridge, which will be known as the Mullard Radio-astronomy Observatory. The grant will make it possible both to obtain the use of the land to provide laboratory buildings, and to construct new instruments. It is hoped in this way to develop a number of the lines of research which now appear to offer great promise. During the past two years a survey of radio stars has been completed at Cambridge which led to the location of nearly two thousand radio sources. Only a small fraction of these could be related to optically observable objects, and an analysis of their apparent distribution in space has suggested that most of them represent an extremely rare and intense class of source; on this interpretation most of the sources observed lie beyond the reach of the most powerful optical telescopes, in regions where the predictions of different cosmological theories diverge. The extension of these observations, their comparison with cosmological theories, as well as work on the general emission from the galaxy and on the structure of the outer layers of the solar atmosphere, represent some of the investigations which it is hoped to undertake at the new Observatory.

International Co-operation on Purification of Brackish Water

Great Britain has joined an international scheme for research on de-salting saline waters by electrodialysis; the work will be carried out in The Netherlands. In many countries, difficulty is being found in providing the increasing quantities of fresh water required for domestic and industrial use. For example, sea-water is infiltrating into freshwater wells in the Thames estuary and it is becoming more and more difficult to suggest other sources that do not involve expensive, long-distance pumping. Talks on the possibilities of various methods of de-salting water have been going on for some time under the auspices of O.E.E.C. One promising process is electrodialysis —the removal of salts from a liquid flowing between pairs of ion-selective membranes, by means of an electric field. Research on this method is already well advanced in The Netherlands. The Dutch recently offered to carry out development work in co-operation with other countries showing an interest. Great Britain has joined The Netherlands, South Africa,

Australia and Algeria (representing France) in paying for this work; the problems to be solved are mainly those of bringing up the process from small to large pilot-plant scale. In Britain, an Admiralty team has been working on scale- and foam-prevention in the distillation of sea-water. The Department of Scientific and Industrial Research has now given £5,000 for an extension of that programme to cover other waters. A Dutch scientist is joining the team. Two other processes have been put forward by the French, namely, certain aspects of ion-exchange and of solar distillation, which may be suitable for use in very hot, dry areas; no co-operative group for their study has yet been formed.

New Discovery at Swanscombe, Kent

Some time must necessarily elapse before a complete study can be made of the portion of a human skull bone discovered at Swanscombe by Mr. and Mrs. B. O. Wymer, Mr. J. Wymer, and Mr. Adrian Jones on August 1. It can, however, be confirmed that the bone is a right parietal, and it fits perfectly with the left parietal and occipital which were discovered on the same site by Mr. A. T. Marston in January 1935. This in itself is very satisfactory, and will enable further evidence to be obtained from the bones as a whole. Meanwhile, the remarkable fact that another portion of the same skull has been found after an interval of twenty years is a striking justification of the policy of the Nature Conservancy in preserving sites of scientific importance. The remaining region of the Swanscombe skull has still to be discovered, and it is very much to be hoped that it will be found during the further excavations which it is understood are to be made. It is therefore of the greatest importance that the site should be protected from damage.

Commonwealth Agricultural Bureaux

The growth of the Commonwealth Agricultural Bureaux, like so many other British organizations, has been one of adaptation and adjustment, often on an empirical basis, to the needs and mood of the time. It dates back to 1909, when recommendations were made for forming an Entomological Research Committee, duly leading in 1913 to the foundation of the Imperial Bureau of Entomology, and to 1920, when an Imperial Bureau of Mycology was started. In addition to these two bodies, now named the Commonwealth Institute of Entomology and the Commonwealth Mycological Institute, respectively, eleven other Commonwealth centres were later founded, as follows: Institute of Biological Control, Bureau of Agricultural Parasitology, Bureau of Animal Breeding and Genetics, Bureau of Animal Health, Bureau of Animal Nutrition, Bureau of Dairy Science, Bureau of Forestry, Bureau of Horticulture and Plantation Crops, Bureau of Pastures and Field Crops, Bureau of Plant Breeding and Genetics, and Bureau of Soil Science. Though these centres are situated in Great Britain, they are essentially Commonwealth organizations and are in the hands of an Executive Council which comprises one member from Great Britain and one from each of the Dominions of the British Commonwealth (including the Republic of India and the Federation of Rhodesia and Nyasaland) and one member representing the Colonial Territories. One of the recommendations of the Commonwealth Agricultural Bureaux Conference of 1946 was that the Executive Council should issue a conspectus showing the subjects or aspects of subjects covered by the journals of the institutes and bureaux. At the same time it was decided to incorporate a brief account of the history and origin of the Commonwealth Agricultural Bureaux organization. As a result, the conspectus was issued in 1949 giving a short description of the history, work, administration and finance of the Bureaux and a detailed review of the subjects covered by each institute and bureau. The conspectus has now been revised and is a valuable pamphlet of nearly fifty pages (London: H.M.S.O., 1955) showing the state of the Commonwealth Agricultural Bureaux at the time of going to press in October last year.

National Institute of Agricultural Botany

In his address to the Fellows of the National Institute of Agricultural Botany, Cambridge, at the annual general meeting of the Institute on July 14, Sir William Slater said that a fundamental feature of the Institute's work has been the introduction of greater precision into the evaluation of the different varieties of agricultural and horticultural crops, and as a result the farmer and grower now have information upon which they can rely. With regard to plant breeding, he believes that undue emphasis is sometimes laid on a search for an ideal variety incorporating all possible good qualities, whereas a sound range of good varieties of known performance, from which the farmer can select according to his requirements, may be preferable. Prof. T. J. Jenkin, chairman of the Council, in presenting the annual report for 1954, referred to the arrangements for transfer from the Welsh Plant Breeding Station of the certification of the Aberystwyth strains of grasses and clovers, and for sowing an additional acreage of foundation seed as the first stage towards full responsibility by the National Institute of Agricultural Botany for the production of stock seed of these strains. A recommended list for the potato crop has been produced for the first time, the certification schemes for cereals have been developed and a new scheme inaugurated for vegetables. Considerable progress has also been made in the national certification scheme for herbage plants. In conclusion, he was able to announce the authorization by the Ministry and Treasury of a capital grant for a much-needed extension to the headquarters building and for improvements in glasshouse accommodation.

Institute of Science Technology

In 1948, the Science Technologists Association was formed for technicians in science laboratories in educational institutions and in industry who were not covered by the Institute of Medical Laboratory Technology. The membership has now grown to approximately 1,300, and many branches have been formed providing for local activities. The Education Board of the Association has arranged examinations at both certificate and diploma level, and the Association has assisted in the training of technicians in other ways and has maintained a technical information service. A primary purpose of the Association had always been the formation of an Institute of Science Technology, and this was accomplished at an extraordinary general meeting of the Association held on May 21. The Institute has been granted a certificate of incorporation and has taken over the affairs of the Association. Membership of the Institute will consist of Fellows, honorary Fellows, associates, ordinary members and registered students; the training scheme approved by the Institute is a

five-year course of study (three years for a certificate followed by two further years for a diploma) leading to the associate grade. Information on the aims of the Institute, examination syllabuses and details of membership may be obtained from the registered office of the Institute: Hon. General Secretary, F. W. L. Croker, Chemistry Department, Imperial College of Science and Technology, London, S.W.7.

Engineering Appointments in Great Britain during 1954

During 1954 the Professional Engineers Appointments Bureau (9 Victoria Street, London, S.W.1) submitted particulars of more than nine thousand engineers for vacancies notified in civil, mechanical and electrical engineering, and this is the highest annual number recorded since the Bureau was set up nine years ago by the Institutions of Civil, of Mechanical and of Electrical Engineers. There has been an increase in the number of registrations with the Bureau, many from overseas, and this increase contributes to the better service which the Bureau can offer to employers. On the other hand, because of the full employment position, there is a reluctance on the part of many engineers to change their employment unless substantial benefits are likely to result. The main demands in civil engineering have been for engineers with wide design experience, good contractors' experience and for young engineers prepared to accept overseas posts; there has also been a big increase in technical vacancies notified by local authorities. In mechanical engineering requirements have been varied and have included posts for engineers with experience in chemical engineering plant, hydraulics, servo-mechanisms, production and management. The major proportion of electrical vacancies have called for experience in the sphere of electronics and light-current engineering, including instruments.

Forestry in Northern Ireland

In an introduction to a well-illustrated pamphlet issued by the Minister of Agriculture in Northern Ireland, entitled "Forestry in Northern Ireland" (pp. 20; Belfast, 1954), a brief historical review is given of the forests of the region in the past. It was not until 1903 that a definite step to stop deforestation, which the great storm of that year had increased, was taken. A forestry branch of the Department of Agriculture was inaugurated, technical instruction was undertaken and Avondale in Co. Wicklow was acquired as the first forestry centre and training school. Progress has been made since then. The forest policy laid down is governed by three principal factors. First, there is the compelling need, which two World Wars have demonstrated, to reverse the centuries-old process of deforestation and to create home-grown timber resources equal to emergency requirements. Secondly, it is necessary to provide productive work in areas of serious unemployment; and thirdly, though private planting can contribute usefully, under present economic conditions any such contribution must be small. A Forestry Act (Northern Ireland) was passed in 1953, and afforestation and other work is proceeding under the Act. As in so much of Britain, sitka spruce is the most important single species in the reafforestation programme.

The German Plastics Industry

The German Forschungsgesellschaft Kunststoffe e.V., a union of 189 firms, was founded in 1953 with the object of promoting the scientific investigation and practical application of plastics (*Kunststoffe*) and the development of the industry. It has founded the Deutsche Kunststoff-Institut in Darmstadt, under the direction of Prof. K. H. Hellwege and in the grounds of the Technical Institute, and the new Institute is expected to be functioning fully at the end of 1956. It will comprise laboratories and workshops, a library and documentary department, and a separate hall of manufacture equipped with all the necessary machinery. The staff will comprise eight to ten physicists, chemists and engineers. The cost will be largely met by members of the Forschungsgesellschaft, with assistance from the State of Hesse. The programme of research will be under the direction of a board, including the chairman of the Forschungsgesellschaft, State and town officials, the Rector of the Technical Institute of Darmstadt, and representatives of science and industry. The foundation stone was laid last May, with appropriate ceremonies, in which the Minister of Education participated. A casket containing specimens of various plastics was enclosed in the foundation stone. The organization has recently established a literary service called a *Literatur-Schnelldienst*, which is available to members and non-members. This is planned to appear monthly and takes the form of a prompt documentation by titles and short abstracts of all publications and patents, both German and foreign, of interest in all branches of the science and technology of plastics. This publication, a specimen of which in the form of photostat copies of sheets has been received at the office of *Nature*, is apparently issued by the Arbeitsgemeinschaft Deutsche Kunstoff-Industrie, 4 Güterplatz, Frankfurt-am-Main 1, the director being Dr. H. Saechtling. The price of the *Literatur-Schnelldienst* is given as 80 DM. to members of the Forschungsgesellschaft and 200 DM. to non-members per annum.

Announcements

The Wellcome Trustees announce that, with the approval of the chairman of the Medical Research Council, they have appointed Brigadier J. S. K. Boyd to be a Trustee as from January 1, 1956, in succession to Prof. T. R. Elliott, who is retiring from the trusteeship in October. Brigadier Boyd is relinquishing the directorship of the Wellcome Laboratories of Tropical Medicine on December 31, and will be succeeded by Dr. R. S. F. Hennessey, who, until his recent retirement, was director of medical services, Uganda.

The following lecturers in the University of Aberdeen have been appointed readers in the subjects stated, as from October 1: Dr. H. W. Kosterlitz (physiology); Dr. T. N. Morgan (materia medica); Dr. W. P. D. Wightman (history and philosophy of science); Dr. W. T. H. Williamson (soil science).

The French Society of Metallurgy is holding its annual "Journées Métallurgiques d'Automne" in Paris during October 24–29. Further information can be obtained from the Société Française de Métallurgie, 25 rue de Clichy, Paris 9e.

The Scottish Group of the Nutrition Society is holding a symposium in Aberdeen on September 17 on "Cholesterol and Fat Metabolism in Relation to Diet and Disease". Both the biochemical and clinical aspects of the subject will be considered. Further particulars can be obtained from Dr. A. M. Thomson, Department of Midwifery, University Medical School, Foresterhill, Aberdeen.

CONFERENCE ON THE EFFECTS OF NUCLEAR WEAPONS

A WORLD conference of scientists to consider the effects of nuclear weapons was organized by the World Association of Parliamentarians for World Government and held at the County Hall, London, during August 3–5. The Right Hon. Clement Davies, president of the Association, opened the conference, and the Right Hon. Walter Elliot took the chair during the subsequent sessions.

Earl Russell opened the debate and moved his resolution urging Governments to acknowledge publicly that their purposes cannot be furthered by world war. He asked scientists to collect together the results of their investigations of the effects of nuclear warfare, and then see that they are clearly expressed in simple language and disseminated as widely as possible. Not only nuclear physicists, but also geneticists, meteorologists, authorities on soil and crops, and other experts will be needed in the investigations. Some of the work has been done already, but what is needed is a series of reports by internationally acknowledged authorities on the subjects concerned.

These reports would make it clear that a nuclear war would not bring victory to either side, but would probably create a planet destitute of life, except for a few mosses and fungi. If nuclear weapons are intended only as deterrents, and there is no intention of using them, then it would seem simpler and more economical to have the deadlock admitted and the impossibility of war acknowledged. War can no longer serve as an instrument of policy. We cannot wait to learn this by experience, because the experience would probably be that of universal death.

It is only the first steps that depend upon men of science as such. Their pronouncements will have to be taken up and clarified and emphasized by leaders of public opinion, who will have to make their weight felt by statesmen of East and West alike.

Another important sphere lying within the scope of science is the possible peaceful uses of atomic energy and of other scientific discoveries. The tendency of the general public to think of scientists as merchants of death must be combated, and it must be made clear that science could and would bring benefits to mankind as great as the disasters it has been rendering possible. If the world were liberated from fear of war, science could abolish poverty and raise the standard of living throughout the world, make deserts fertile, and ameliorate inclement climates.

Collective hatreds have darkened history since the dawn of organized society. They are about to cease, either because no one will be left alive to feel them, or because men will have learnt the elementary wisdom that only by overcoming collective hatred can the human race survive.

Earl Russell was followed in the debate by a number of distinguished speakers, including Prof. J. de Castro, Prof. M. L. Oliphant, Prof. E. Rabinowitch, Prof. A. J. Ayer, Prof. A. Topchiev, Lord Boyd Orr, Lord Beveridge, Prof. C. H. Waddington, Prof. R. W. Ditchburn and Prof. G. Boschi. They generally welcomed his proposals, in some cases with reservations, and stressed the dangers of nuclear weapons and the importance of developing the peaceful uses of nuclear energy.

On the second day, the scientists divided into three commissions to study the destructive potential of nuclear weapons and the hazards of the large-scale peaceful use of nuclear energy, the international control of atomic energy, and the individual and collective responsibility of the scientist. The other delegates debated the responsibility of Parliaments in the nuclear age.

The main task of the three commissions was to define more precisely their terms of reference and, where possible, to pose the questions that need to be answered. It is proposed that their reports be circulated to interested scientists all over the world with a request for comments, suggestions and details of scientific and technical investigations bearing upon them. These will be incorporated in a final report to be presented at another conference to be held in The Hague about a year hence.

The first commission examined the destructive potentials of nuclear weapons, the possible consequences of their massive use in war and in tests, and the possible harmful effects of the peaceful uses of atomic energy. It was agreed that its investigations should be carried out under the following headings: (*a*) physical destruction; (*b*) effects on individuals; (*c*) effects on animals and crops; (*d*) long-term genetical effects on human beings, animals and plants; (*e*) meteorological effects; (*f*) effects of a rise in the general level of radioactivity in the atmosphere and the soil. Prof. J. Rotblat, of the Physics Department, Medical College of St. Bartholomew's Hospital, Charterhouse Square, London, E.C.1, was appointed secretary of the commission.

The second commission examined the technical problems of the supervision and control of the production and use of nuclear weapons with the view of enforcing their prohibition. A number of questions for further study were posed and classified under five headings: (*a*) Detection of existing weapons and fissile materials: Can direct physical methods or other indirect methods be used for the detection of existing nuclear weapons and fissile materials, and if so, what are they? (*b*) Inspection of means of delivery of nuclear weapons: Can surprise attacks be made impossible by setting up a system of control of the means of delivery of such attacks, or of dangerous concentrations of air, naval or land forces for such an attack; for example, by establishing points of control in ports, road junctions, airfields, etc.? (*c*) Control of mines and plants producing or employing fissile materials: Are the possibilities of the control of diversion from these plants of fissile materials affected by new scientific or technical developments, and are there methods by which the conversion for military uses of materials used in power plants can be made difficult or preventable? (*d*) Adaptation of controls to possible future developments: Can the control methods be made flexible enough to be adaptable to possible new developments such as new methods of initiation of thermo-nuclear reactions? (*e*) Nuclear weapon tests: How could nuclear tests be detected and how effective could be the cessation of such tests?

The commission said that the study of these questions would be greatly facilitated by closer international co-operation of scientists, and by the reduction of secrecy to a minimum. Dr. P. E. Hodgson, of the Physics Department, University College, London, W.C.1, was appointed secretary of the commission.

The third commission examined the responsibility of scientists for the direction of their work, the uses to which it is put, and public knowledge of its implications. Dr. J. Bronowski, of the National Coal Board, Central Research Establishment, Stoke Orchard, Cheltenham, Glos, was appointed secretary of the commission.

The representative character of the conference was increased by the presence of a delegation from the U.S.S.R. comprising Academician A. Topchiev, professor of organic chemistry and general secretary of the Academy of Sciences of the U.S.S.R., Prof. C. A. Golounsky, director of the Institute of Criminology, University of Moscow, Prof. A. V. Kusin, a biochemist, and Prof. M. A. Markov, a theoretical physicist. The atmosphere of the discussions was cordial, and their conclusions unanimous.

The final day of the conference was devoted to the presentation and discussion of the reports of the three commissions. At its close, Earl Russell moved his resolution, which had been slightly modified as a result of the previous day's discussions: "Since in any future world war nuclear weapons will probably be employed and since such weapons threaten to bring immeasurable suffering for humanity, and material destruction, and possibly even the end of mankind, we urge, therefore, the governments of the world to realize and to acknowledge publicly, that their purposes cannot be furthered by world war; consequently we urge the full and open examination of the implications of recent scientific developments for humanity as a whole and the promotion of peaceful means for the settlement of all matters of international dispute". The resolution was carried unanimously.

P. E. Hodgson

LONG ASHTON RESEARCH STATION

FIELD-DAY

FIELD-DAY was held at Long Ashton on July 20 in conjunction with the fifty-second annual general meeting of the governors, members and associates of the National Fruit and Cider Institute. Captain D. M. Wills, chairman of the governors, presided.

In reviewing the work of the Station during 1954, the director, Prof. T. Wallace, referred to the promising results obtained from foliage sprays and soil dressings of chelated compounds of iron in the control of lime-induced chlorosis of fruit trees. Although these compounds, derived from ethylenediamine tetra-acetic acid and related substances, are as yet expensive, he believes that the residual effects obtained from a single application to calcareous soils make it likely that they can be developed to replace the present tedious technique of injecting pellets of ferrous sulphate into the trunks of affected trees. The chelates have been found to be photosensitive, and it is therefore necessary to water them well into the soil to prevent their breakdown at the soil surface.

In a brief account of the work of the Agricultural Research Council Unit of Plant Nutrition, Prof. Wallace recalled Dr. Nicholas's participation in experiments at the McCollum Pratt Institute which had shown molybdenum to be an essential constituent of the flavoprotein enzyme, nitrate reductase; he outlined investigations that are being made on other metallo-flavoproteins and on the valency changes of molybdenum within plants.

In a tour of the plantations, members saw three-year-old trees of Cox's Orange Pippin and Bowden's Seedling that had been newly grassed-down in further studies of the effect of cover crops on the availability of soil nutrients and of their interaction with fertilizer treatments. Experiments made with cider-apples between 1946 and 1952 had shown that, compared with clean cultivation or annual cover-crops, a grass cover rapidly increased the potassium and phosphate status of the leaves while decreasing the nitrogen status; the effects on tree growth and fruit yield had not been readily determinable as the trees had been well established when the covers were sown.

Current trials with growth-substances were demonstrated. In the search for a compound suitable as a thinning-agent for heavy-bearing varieties of apple, naphthylacetamide has been tried for the first time in place of α-naphthalene acetic acid (NAA), which had caused a loss of marketable crop in a number of consecutive years. Sprays of the amide applied four days after petal-fall gave variable results: they had drastically over-thinned test branches of Crawley Beauty when used at half the strength (50 p.p.m.) recommended in the United States, whereas they had failed to effect any thinning of Laxton's Superb even when used at 1½ times the recommended strength.

From the bareness of their branches it was possible to distinguish trees of Worcester Pearmain that had received sprays of 30–50 p.p.m. 2 : 4 : 5-TP (2 : 4 : 5-trichlorophenoxy propionic acid) in August 1953. Treatment had permitted apples of good quality to be harvested fourteen days in advance of the normal crop, and had seemed likely to prove valuable to growers anxious to catch the early market. Damage to the treated trees had, however, become apparent early in 1954, when their yield was only 25 per cent of that from untreated controls. The uncertainty attending empirical trials of growth-substances has served to emphasize the importance of the investigations that Long Ashton has been making since 1946 into the production of natural auxins during the development of apples and other fruits.

Members were also shown experiments to decide the best method of rooting gooseberry cuttings, and demonstrations were made of the frame-working and top-grafting of apples and of the spraying of dwarf pyramid apples by an automatic machine developed at the Research Station.

Laboratory exhibits illustrated the techniques used in determining the performance of spray machinery and materials: these included measurements of droplet size, of the distribution and persistence of various formulations of copper compounds on potato leaves, and of the residues of DDT and captan on apples and other fruits. A new method for the determination of small amounts of captan has shown a maximum deposit of 19 p.p.m. on fresh strawberries successfully sprayed in 1954 against *Botrytis*, using three applications at 0·25 per cent. While no taint had been apparent in the fresh fruit, a slight taint had developed during the storage of canned fruit.

Other exhibits showed the use of radioactive tracers to follow the passage of systemic insecticides through bean and apple plants; and the production of cankers on apple trees by inoculation with mycelium or spore suspensions of *Gloeosporium perennans* and the formulation of a BHC–DDT emulsion as a substitute for winter washes for apple trees. The need

for supplementing this emulsion with a later spray against the red spider mite (*Metatetranychus ulmi* Koch) was stressed, and favourable reports were made of the acaricide chlorbenside (*p*-chlorphenyl *p*-chlorbenzyl sulphide), which has given nearly complete kill of the winter eggs of the mite when applied at 0·05 per cent just before hatching of the eggs.

In an array of casks and bottles appropriate to the occasion, the Cider and Fruit-juices Section included attractive samples of concentrates and syrups prepared from black currants, strawberries and raspberries. Paper chromatograms showed the amino-acids distinctive of apple and pear juices and the changes in organic acids taking place during fermentation. Besides the bacterial breakdown of malic acid to lactic and succinic acids, the reduction of quinic acid to dihydroshikimic acid has recently been observed, a finding of some interest because of the role postulated for quinic acid in aromatic biosynthesis. Chromatograms of leaves of apple and pear and of the apple–pear hybrids produced by Mr. M. B. Crane at the John Innes Institution demonstrated that the hybrids had inherited the phenolic (tannin) components of both parents.

The cider-house contained a collection of gooseberries showing the characters that are being used in their classification, which is at present very confused; there was also a selection from the many varieties of perry pear collected during the past two years in a survey of West Midlands orchards, arising out of a revived interest in perry. The longevity of perry pears ("He who planteth perry pears planteth truly for his heirs") was illustrated by a recent photograph of a vigorous tree planted at Holme Lacy, Herefordshire, in 1790, and reputed at one time to have occupied ¾ acre and to have yielded five to seven tons of fruit in one year.

ENDOCRINOLOGY AND AGEING

A MEETING of the British Society for Research on Ageing was held at the Ciba Foundation, 41 Portland Place, London, on June 9.

The opening paper was read by Dr. V. Korenchevsky on "Endocrinological Aspects of Gerontology". He pointed out that in studying the relationships of the endocrine glands to ageing processes the following three points have to be taken into account: (1) the changes in each gland with age; (2) the effects of their hypo- or hyper-secretion, as the case might be, in old age; (3) the use of hormones in treating the ailments of old age.

In the case of the testis, Dr. Korenchevsky listed eleven changes which are characteristic of both ageing and castration and twelve which differ in these two conditions. Among the former are atrophy of liver, kidneys, heart and skeletal muscles, an increase in fat deposition and fatiguability and a pale, lifeless, non-elastic skin. On the other hand, the adrenals and the pituitary are atrophied in old age, but hypertrophy as a result of castration. Dr. Korenchevsky pointed out that castration can accentuate old-age changes, quoting the results of his own experiments on senescent rats, and those of previous workers, who have shown that castrated men of forty look like old men of sixty.

The thyroid gland in old age shows degenerative and sclerotic changes; but in some cases an apparently normal or even hyperactive gland has been found. However, the fact that most thyroids show degenerative changes in old age has for some time led to thyroid deficiency being thought of as a primary cause of ageing. Experimental evidence shows that thyroid deficiency is not itself the primary cause of ageing; but it can intensify and accelerate those degenerative processes which are present both in ageing and thyroid deficiencies. There is a possibility, on the other hand, that excessive thyroid secretion might accelerate ageing by wearing out the organism.

Ageing and hypofunction of the adrenal have some six effects in common, namely, increased fatiguability, asthenia, tendency to skin pigmentation, low basal metabolism, accumulation of toxic metabolites, mental depression and apathy. On the other hand, adrenal hypofunction produces hypotension and old age tends to produce hypertension.

The conclusions presented by Dr. Korenchevsky were that while degenerative changes in the three endocrine organs considered can produce, and therefore intensify, many of the conditions present in old age, they are not the basic causes of ageing. Experiments on senescent rats by Dr. Korenchevsky and recent clinical observations show that the hormonal treatment might be useful only in those cases of old age in which there is a deficiency of the respective endocrine. The treatment removes this deficiency and the intensifying effect which it exerts on the processes of ageing.

Following Dr. Korenchevsky's general survey, three papers were read—two on the ageing ovary and one on hormonal changes in the menopause. These included a thoughtful discussion of the ovary by Prof. P. L. Krohn, an interesting paper on hormonal relationships in the menopause by J. A. Loraine and a detailed account of a critical series of researches carried out in Amsterdam by Dr. O. Mühlbock and Drs. L. Boot and P. J. Thung. The latter paper was read by Dr. P. J. Thung.

Prof. Krohn pointed out that in considering the ageing processes it must be remembered that the ovary is a composite organ with several jobs to do; for example, it has not only to produce ova but also a series of reproductive hormones. The ageing of these two functions may not always run in parallel. Also a specially produced tissue, such as the corpus luteum, has a life and an ageing time-table of its own, not necessarily related to the other ovarian changes. Furthermore, the fœtal ovary (for example, in the mare) may be twice the size of the mother's ovary, due to great overgrowth of the interstitial elements, and the subsequent degeneration of these cells might be described as a form of ageing. While all these factors must be taken into account in studying the ageing ovary, the reactivity of the endometrium to hormonal stimulation must also be considered. The uterine endometrium in women, for example, remains after the menopause responsive to the injected hormones for a considerable period of time. Presumably, therefore, the menopause is due to ovarian hormonal changes rather than to change of reactivity of the uterus. Presumably this again is a case of ovarian functions ageing at different rates, for women have been known to become pregnant after several years of amenorrhœa, which suggests that the ovulatory processes have not aged as rapidly as the hormonal. That a completely menopausal ovary is still fulfilling some sort of function is indicated by the fact that a second series of menopausal

symptoms can follow the removal of post-menopausal ovaries.

The reproductive life in animals seems to continue, although becoming reduced, as the animal becomes older, and a post-menopausal period in women is a biological luxury of very recent origin.

Apart from the ageing of the ovary, the ageing of the individual ova must be considered. Two schools of thought exist here. The first believes that the ovary receives its quota of ova early in its life, and the other that new ova are constantly being destroyed and formed. This controversy has not yet been settled, although Prof. Krohn expressed some bias towards the former view.

Dr. Loraine directed attention to the fact that gonadotrophin titre in both the urine and the serum of menopausal and post-menopausal women is relatively high. It was shown by Heller and Shipley in 1951 that women who are less than twenty-five years beyond the menopause have a gonadotrophin excretion significantly higher than those in whom menopausal symptoms occur more than twenty-five years before the investigation. Menopausal gonadotrophin resembles in its biological properties the gonadotrophins excreted by men and by non-pregnant women. It has been generally assumed that menopausal urine contains entirely, or predominantly, follicle-stimulating hormone. Recent work in Edinburgh has, however, shown that this material is in addition a relatively rich source of a hormone stimulating interstitial cell activity.

Bioassay methods have indicated that although the amount of œstrogen excreted by menopausal women is less than in those living a normal reproductive life, it is surprising that it still occurs at such a relatively high level considering that the menopause is a condition characterized by ovarian failure. Parkes in 1937 suggested that the adrenals might be the source of post-menopausal œstrogens. An accurate, sensitive and apparently specific chemical method by estimating separately œstriol, œstrone and œstradiol 17β has now been developed in Edinburgh by Brown. Confirmation of the bioassay work has been obtained in preliminary experiments using these methods.

Two theories have been put forward to account for menopausal symptoms. The first is the theory of gonadotrophin excess, and the second the theory of œstrogen lack; but there is now a good deal of evidence that the former is not correct. Even though the œstrogen withdrawal theory seems more likely, there are still several objections to this, and it seems that neither of the hormonal theories explains the cause of menopausal symptoms.

Dr. Thung pointed out that the involutionary changes in the mouse ovary are similar to those in man, the most characteristic of these changes being the decrease in the number of follicles until, finally, only a few degenerative follicles are left; however, there are some changes which take place in the ageing mouse ovary which are very different from those found in the ageing human ovary.

This is due to fundamental differences in structure between the two types of ovary. The human ovary has a connective tissue core, the medulla, around which lies a relatively thin cortical portion which contains the follicles and corpora lutea. By comparison, the mouse ovary contains very little interstitial tissue and no medulla: it is little more than a cluster of follicles and corpora lutea. Also, the mouse ovary during its reproductive period (about one year) produces a much larger number of follicles, both mature and atretic, than the human ovary in a similar period. Moreover, each of these follicles is destined to a shorter existence. The human ovary in ageing becomes progressively more fibrotic, whereas in the mouse ovary very little fibrous scar tissue is formed—the cells of the degenerating follicles simply disintegrate and disappear. The pellicles surrounding the degenerating ova survive as crinkled remnants and often become calcified. In strains of mice susceptible to amyloid degeneration, more parenchyma is present in ageing ovaries; and hyaline infiltration may occur, particularly in the corpora lutea, which may afterwards also become calcified.

In ageing mouse ovaries, large phagocytic cells filled with lipo-fuscin pigment (ceroid) appear and increase in number with age.

These aged ovaries may still show some functional activity; for example, an œstrous cycle persists in the vagina of the mouse (vaginal smear technique) long after the loss of fertility, and these have in some cases been observed to persist even up to the moment of death. This suggests that some part of the ovary continues to secrete œstrogenic hormones. This may, in fact, be the germinal epithelium, which not only becomes more obvious but also seems to have a proliferative tendency in the old ovary, resulting in small ingrowing tubules and producing certain cell groups which look like small follicles without ova.

G. H. Bourne

WINTER OBSERVATIONS ON A ZONE OF CLIMATIC MODIFICATION IN THE NORWEGIAN ARCTIC

By N. C. NEGRI

Leader and Meteorologist, Lyngen Winter Survey Expedition

During the post-war period of exploration, no less than seven scientific expeditions visited the Lyngen Peninsula, 250 miles beyond the arctic circle on the north coast of Norway. However, all these parties confined their observations to the summer months; consequently there was no information relating to the prevailing winter conditions in the region. By the autumn of 1954 the need for such observations was such that the newly formed Mount Everest Trust Foundation agreed to sponsor a "comprehensive winter survey". The Royal Geographical Society approved the final plans, and supplied much of the necessary equipment.

This article summarizes the climatological observations made in a zone of modification at the head of a fjord on the north-west coast of the peninsula. The inner reaches of this fjord were separated from the main valley by two spits and an island. For the purposes of comparison, the expedition established a full-scale meteorological station half a mile north of these spits.

The mountain basin south of the spits clearly had an unusual local climate, for we observed the salt water within it freezing, although the temperature at the station was above 29° F. After a brief investigation of the general conditions in the basin, we reached the conclusion that the cause of the phenomena was a cold air stream from the south. This

much was obvious; but the task of locating the source of this air stream was a complex problem, with the normal difficulties of field-research increased by the extreme conditions of the locality, and the limited daylight. We decided that the only certain method of fixing the position of the source would be by establishing the relative situation of the lowest temperature in the basin at sea-level, and tracing the source from there. We accomplished this by circumnavigating the basin, measuring the temperature at frequent intervals. Eventually we succeeded in compiling sufficient reliable figures to plot isotherms for the region. Simultaneously with these journeys, we ascended the slopes of the mountains rising from the basin, in order to determine the vertical extent of the climatic zone. The inversions recorded on all occasions showed the temperature at 1,000 ft. to be 10° F. higher than that at sea-level. The curve of this temperature gradient indicated that the rise took place mainly in the upper 500 ft.

All the temperature-recording journeys proved beyond doubt that the very lowest temperatures occurred at a point just south of the fjord-ice at the base of a wide defile leading to a glacier-filled cwm, at an altitude of 1,500 ft. As the mountain walls on either side of the defile reached heights exceeding 2,000 ft., it was safe to assume that the glacier cwm and the defile itself were both free from wind, and therefore unlikely to be affected by cold air currents from the interior of the peninsula. It followed from this that the source of the cold air stream was the glacier.

The sequence of events from the time that a parcel of cold air accumulates near the snout of the glacier can now be traced. By virtue of its greater density, the glacier-cooled air would push itself under any comparatively warm air in the vicinity, and flow down the subsidiary valley formed by the rock walls of the defile. On reaching sea-level, it would attain a state of almost complete stability, that is to say, there would be little or no convection within the air itself, or heat exchange between the snow cover of the basin and the air. In relation to the latter, it should be remembered that, for a climatologist working during the Arctic night, the polar nocturnal constant relieves him of problems of solar or terrestrial radiation.

Having reached the valley floor, the parcel of air would flow over the surface of the fjord-ice toward the open water in the north. As it approached the warmer air near the water, it would cease to be a level stratum, and become instead a wedge of air, behaving in exactly the same manner as a macroclimatic cold front. The water in the fjord was always 20° F. warmer than the air from the south, and therefore a fog layer 5 metres thick and 3 metres above the surface of the water would form at the point of occlusion.

Our conclusion from the above was that, during winter months when the moderating factors of radiation and reflexion were set at nought by the absence of the sun, the local climate of the mountain basin was entirely dependent upon the glacier at the southern extremity of the fjord valley; also, that this modification of macroclimate was quite out of proportion to the relatively small area occupied by the glacier.

The significance of such an area is obvious when one considers the difficulties of studying the relationship between glaciers and climate in the lower latitudes of Europe, where the climatologist has to account for an extremely wide diurnal temperature-range and other complicating agents, such as nocturnal heat exchange, ablation of the snow, and erratic winds. All these disturbing influences are removed during the period after the winter solstice, and it is possible to obtain almost perfect continuity in climatic observations until the return of the sun in February. So it may be said that, in the glaciated areas of Arctic Scandinavia, the climatologist has a virgin field, easily accessible, and abounding in possibilities for winter research on a smaller, and consequently more accurate, scale than is at present possible in Austria or Switzerland.

AUTOMATION IN THE SOVIET UNION

THE U.S.S.R. claims to have achieved the automatic factory, but little detail is available; more definite information, at least indicating some of the lines along which research in this field is proceeding or is contemplated in the Soviet Union, may possibly be found in reports of two recent conferences: one on the modern theory of machines, and the other on the progress of automation in the consumer goods industries—mainly food and textiles.

The first of these, reported in *Vestnik Akad. Nauk SSSR*, No. 12, 1954, is by I. I. Artobolevskii and co-workers, and is chiefly devoted to the paper they themselves read at the conference, with a few brief notes on some of the other papers. The meeting was organized by the Institute of Machine Construction (affiliated to the Academy of Sciences of the U.S.S.R.), and was an attempt to strengthen the scientific foundations of the machine construction industry.

Artobolevskii's paper emphasizes the importance of the theory of machines and mechanisms, especially in relation to the growing demands of automation. Discussing first of all the general theory, he thinks this is fully developed only in the case of prime movers, and as yet very imperfectly in other directions. A main factor to-day is the greatly increased speed of operation and general efficiency, the effect of which still requires close study. But the most important direction for the development of modern machine design is that of automatizing and mechanizing technological or industrial operations. In recent years in the Soviet Union many types of automatic machine have been evolved. Automatic and continuous production lines have been widely adopted. Most of the heavy and laborious operations in mining, metallurgical, building and other industries have been mechanized. Soviet scientists have discussed many fundamental questions relating to automatic machines and mechanisms. More especially they have outlined the general theory of the cyclogram automatics, analysed problems of regulation and control, suggested means and methods for design of individual types of mechanisms, and so forth.

Many difficulties in the theory of automatic machines still await discussion and solution. Among the fundamentals, for example, are the dynamics of free-flowing bodies or material to be mechanically ground, screened and conveyed; the dynamics of bending or flexing of fibres and threads in textile, cable-making and similar machines; the hydrodynamics of viscous liquids to be treated in separators, centrifugal or other; the aerodynamics of air currents in wind motors and the like, including the various kinds of pneumatic mechanisms. These

matters and many others demand specialists in mechanics, physics and chemistry, and their close co-operation. The author also refers to the need for rationalizing the form or geometry of the working organs and tools in a wide range of varied operations. A valid theory of working processes and operation should form the basis of generalizing methods of tool-form design.

A study of power and kinetic characteristics is also essential, and needs carefully planned experiment, with the development of methods and instruments for recording movements, speeds, accelerations, forces involved, and capacities. An important part here will be played by the new electronic, acoustic and electromagnetic devices, radioactive isotopes, the piezo-effect and other means now being applied. Calculation and design of automatic machine units involves furthermore a precise knowledge of their "kinetic layout (scheme) in principle", and more specifically their operational cycles and relations.

The cyclogram theory requires further development, since the determination of one or the other working cycle depends not only on the particular process or function, but also on speeds and accelerations of the several units, and the forces actuating these. From analysis of all these characteristics a general cyclogram may be constructed, conforming to the optimum performance of the machine with minimum expenditure of power on unproductive wastes or losses and maximum equalization of torque on the driving shafts.

The author proceeds to analyse the various mechanisms taking part in the operations: driving, transmission, directing, controlling, speed variation, stopping, etc. Special reference is made here to the design of cam mechanisms of the three-dimensional type, with the complaint that, in their kinetic and other aspects, theory has been little developed in the Soviet Union. Much the same applies to lever mechanisms, to non-stepped drives—so important in automatic machines—and to other units. Research in hand in some institutes in these and some other fields must be both intensified and extended.

Some of the fundamental differences between automatic and non- or semi-automatic machines are noted. In the former, a control unit called a 'datchik' appears to be of primary importance. It has been variously designated by British engineers as a booster, a pickup, etc. By means of suitable 'datchiks', variations in such parameters as speed, pressure, temperature, volume or density, are transmitted to the appropriate controls. In general terms, the author refers to certain lines of progress in the Soviet Union in the matter of controls not only for solids, but also for other forms of product, in statistical controls and computers, in programming, and so forth.

Other matters discussed also in general terms include the effect of clearance or play in kinetic couples, resilience, forces of dry and lubricated friction—requiring new methods of study and experiment—and temperatures. The hydrodynamic theory of friction is said to be well developed on the mathematical side, but less so on the experimental. The author considers that one of the most important parts of modern machine theory relates to machines in series or aggregates. Hitherto it has been developed quite separately for prime movers on one hand and the operative machines on the other; but under modern conditions the boundary line between these two classes is sometimes quite obliterated. It is now essential to regard the aggregate as one entity.

Somewhat more definite, but still largely in general terms, is an article in an earlier issue of *Vestnik AN* (No. 8, 1954) by N. N. Shumilovskii on some problems of automation in the Russian consumer goods industries, primarily as a means of increasing output of these goods and removing some of the bias in favour of heavy industries that has lately marked Soviet economy. His article is based on a recent conference sponsored by the Institute of Automatics and Telemechanics in collaboration with Ministry of Consumer Goods Production. Some of the fundamental requirements for conversion to complete automation and the creation of the automatic factory are indicated. These include close examination of particular cases of complete automation, preferably of a more or less standard type, so that the experience gained can be widely applied.

Some of these basic problems were discussed in a paper by V. A. Trapeznikov, with a certain amount of detail in other papers read at the conference. By way of example, conditions in the cotton industry were considered, in its different divisions: spinning, weaving and finishing. In the first there is a continuous production line, with almost complete mechanization; but there is scope for more automation. In weaving, automatic machines are mainly used, but certain difficulties still remain: maintaining constant (*a*) tensions of thread at various stages, (*b*) temperature, level and viscosity of sizes, and (*c*) moisture content of yarn; (*d*) automatic warning of flaws, and stoppage for breaks or completion of bale, or wrong patterns, etc. Various manual operations remain to be mechanized and automatized: feeding yarn, joining ends, winding and cutting threads, and removing product. Automatic control is also widely used in finishing; but much scope yet remains. A few solution strengths are controlled: sulphuric acid, sodium hydroxide and hypochlorite; but there is no suitable automatic control of moisture content of fabric after drying. In printing, too, the superposing of different coloured patterns in multi-colour work, along with other operations, should be automatized. Continuous automatic lines with cascade electric drives should be developed, providing the required range of speeds and automatic control of tensions.

The problems are widely different in tanning. Here there may be forty to fifty operations, of which up to 60 per cent may be mechanized in the best Soviet factories. With the aid of conveyors, cranes, telpher lines, automatic loaders, etc., mechanization at least (automatic or not) could be raised to 90 per cent. Suggestions for automatic continuous production lines have already been put forward by inventors and innovators, with a series of mechanized units of a new kind. Measuring devices, automatic controls of humidity, of dyeing, drying, spraying and fixing have yet to be perfected.

The author proceeds to discuss the progress made in some of the food industries, where automatism is in various stages. During the past few years, bread-making has been highly mechanized; but automatic controls are still lacking in respect of moisture content of dough, temperature and moisture in the ovens, level of dough in the kneaders, and in other directions. In the confectionery trades much also yet remains to be done, although it is claimed that an automatic device has been evolved for caramels, with pressure and temperature control, and with automatic discharge periodically during continuous operation of the vacuum cooker.

In dairy work, although mechanization is said to have reached an advanced stage, from which the transition to almost complete automation should be relatively easy, this has not been accomplished. The so-called Meleshin method of making butter is cited as an exception; the process is said to have many features of interest, though none of these is described. The production cycle-time is reduced from 20 hr. to 40 min.; the butter is of high quality and keeps well in storage. It ought not to be difficult to extend automation generally throughout the dairy and allied industries, at all events so far as concerns the control of fat, sugar and other ingredient contents.

In the oils and fats industry, modern plant has been more extensively adopted, including continuous instead of batch operation both in production of the oil and in its refining. Some progress is reported in the matter of automation, but methods are still imperfect in respect of controls for certain operations: determinations of oil and moisture content, automatic weighings and feeds. Reference is made to new devices for automatic quality-control of products and of filter-press operation based in some way on dielectric losses; but no details are given. W. G. Cass

BASIC RESEARCH IN THE UNITED STATES

THE concern which is felt in the United States over the increasing dependence of basic research upon Government support is reflected in three papers contributed to a symposium on the roles of Government, industry and the university in basic research. The symposium was held in Berkeley, California, on December 30, 1954, and the papers have now been published in *Science* (**121**, 781; 1955). Discussing the role of Government, P. E. Klopsteg, of the National Science Foundation, defines basic research as the systematic endeavour, without preconception, to increase our knowledge and understanding of Nature, and he suggests that, if this definition could be applied precisely, the Government funds given for this purpose, estimated at 116 million dollars, 120 million and 131 million dollars for 1953, 1954 and 1955, respectively, would be drastically revised downwards. Nevertheless, the Government contribution is now many times greater than before the Second World War, and without discussing all the implications of such dependence on Government support, apart from the possibility of an ultimate deterioration in the quality of research and of bureaucratic interference with the administration of institutions of higher learning, Mr. Klopsteg thinks that Government policy should seek to encourage greater support of basic research both by corporations and individuals. For this he suggests that the income-tax law pertaining to charitable donations should be revised so as to encourage donations by taxpayers to basic research by one of three methods outlined which provide strong incentives for giving.

While the Government would still have an important responsibility for the direct support of research in its own laboratories and for the support of such research at educational institutions and of large projects by team research, Mr. Klopsteg considers that the proposals he makes would check the trend towards almost exclusive dependence on Government support. Institutions would derive their major support from private donors and corporations. Research would be kept free, and the severity of many problems originating in the inadequacy of funds for higher education would be reduced.

Mr. M. E. Speght, of the Shell Oil Co., New York, discussing basic research in industry, gives the number of research workers in the United States as 450,000, of whom more than a third have a bachelor's degree. Expenditure on industrial research laboratories is put at 2,500 million dollars, of which 1,100 comes from Government sources, and about 150,000 persons are employed in such work. Taking the total man-power, research costs are estimated at 7,000–10,000 dollars a year; but for professional workers the medium costs are about 15,000–25,000 dollars a year. Defining basic research as scientific inquiry carried on, not under pressure of immediate needs or in hope of quick profit, but with reasonable hope of some eventual payment, Mr. Speght estimates that industry employs some ten thousand people, four thousand of whom are professionals, and spends a hundred million dollars a year on such work, of which about ten million dollars is in support of research in universities and other non-profit institutions. The limits on basic research are most likely to be set by the number of worth-while ideas that the scientific worker of the organization can propose; but Mr. Speght agreed that a greater investment in the search for new knowledge is necessary if the present rate of technological advance is to continue. He also believes that industry's contribution, particularly to universities and their affiliated research institutes, will continue to increase, and he does not think that this trend can be interrupted by a business recession.

Discussing the role of the university, Prof. K. S. Pitzer recognized the inadequacy of university budgets in the United States even for the present level of basic research, and welcomed the effect of all Government aid to research. The administration of Government funds for this purpose by various Government agencies has been excellent; but he criticized the practice of breaking down the funds into very small units tied closely to particular projects. Funds made available to the universities on a broad basis are used very much more effectively, and he thought that both Government and industry could contribute to improved methods in the future.

GRANTS TO STUDENTS IN TRAINING COLLEGES IN BRITAIN

THE Working Party on Grants to Training College Students, on the recommendations of which the increased grants recently announced by the Minister of Education are based, was appointed in January 1954, with Mr. A. E. Miles Davies as chairman, to work out the costs which students at training colleges in Great Britain are called upon to meet and which are known to vary substantially and merit examination; the amount which parents or students should be required to contribute; the distribution of the balance over all local education authorities; and the reduction of the range of "incidental expenses". The then Minister of Education, Miss (now Dame) Florence Horsbrugh, in appointing the Committee, made it clear that she could not entertain any suggestion for relieving local education authorities of their present responsibility for sharing this expenditure with the Exchequer in

the usual proportions. Accordingly, the more radical proposals of the National Union of Students and of Political and Economic Planning fell outside the terms of reference of the working party; it may be noted that Prof. R. Pascal, of the University of Birmingham, demurred at these latter proposals in an article in the *Universities Review* last October and gave as his main reason that they would abolish the association of the local authorities with the universities in this connexion—an association which, like the Association of University Teachers in its "Report on University Development, 1944", he believes to be of real value.

The report of the working party* opens with a brief survey of the present system and then discusses the two main criticisms. The first is that the grants for personal expenses which are made to about 60 per cent of all students, usually ranging between £20 and £50, but sometimes exceeding £80, are now generally considered to be inadequate; the gross cost to local education authorities is about £510,000, and the Exchequer meets some 60 per cent of this. Some suitable candidates are accordingly deterred from entering upon a course of training, and others, apart from completing their course only at the cost of hardship to themselves and their parents, are adversely affected by uncertainty about their resources, by enforced parsimony in their outlay on books and other necessary items or loss of social and cultural opportunities for development.

Secondly, there are wide variations among the education authorities in the amounts of assistance they offer and their arrangements for relating grants to income. Some limit their assistance to students with net parental income less than £500, and under the schemes of some thirty authorities a parental net income somewhat above £500 may disqualify a student from receiving any assistance towards personal expenses. About half the authorities make grants to students whose parental net incomes exceed £500, even though these students are at the same time required to pay a student's contribution under the Ministry's regulations, and the scales of some fifteen authorities provide for grants at net incomes exceeding £900. One or two authorities do not exercise their powers to make grants, and a few offer loans instead of grants or in conjunction with them.

In both these respects the financial position of training college students compares unfavourably with that of students at universities who are being assisted either by the Ministry or by local authorities. It was common ground, from the outset, among members of the working party that the present arrangements are vulnerable to complaints of unjustifiable variation, and investigation of the amount of personal expenses amply confirmed the criticism of general inadequacy. Their inquiry revealed an unexpectedly wide range of variation in estimates of personal expenses taken as a whole and for particular items such as clothing; but they formed the opinion that the wide diversity of practice among the training colleges in their interpretation of their responsibility for providing tuition, board and lodging, which leads to such variation, is undesirable, and they are convinced that the colleges should jointly review their arrangements in this respect with the view of adopting broadly similar practices in the division of expenditure between themselves and their students.

* Ministry of Education. Report of the Working Party on Grants to Training College Students. Pp. 28. (London: H.M.S.O., 1955.) 1s. net.

In making its proposals for a standard rate of grant, the working party envisages a grant which, for personal expenses, at the maximum, should cover the essential needs of students of no means, and for vacation expenditure should reasonably involve some contribution from their families towards their support in the family household. On these considerations and on the basis of the available evidence, it recommends that a total grant of £160 throughout the period of the two-year course should be generally adopted as the standard maximum grant, providing adequately for necessary personal expenses for a student of no means and also a reasonable contribution towards maintenance during vacations. For a student of no means it also recommends that the standard grant for personal expenses should be increased by an amount assessed individually to cover the ascertained cost of travel between home and college at the beginning and end of each term. Day students who live at any considerable distance from the training college should also be eligible for a similar allowance towards the cost of their daily travel. The standard rate of grant should be subject to triennial review at the same time and by the same machinery as the review of the university standard figures of maintenance. In view of the heavier expenditure incurred in the student's first year, it recommends that £30 of the total grant should be paid as an initial allowance before the student enters college and the rest in two equal annual instalments of £65.

The working party also considered the needs of women students attending three-year specialist courses in housecraft or physical education and a request for a higher annual rate by representative principals from the colleges providing the courses. The working party reached the conclusion that, for a housecraft student, a total grant of £240, £45 being given as an initial allowance and the remainder in three annual instalments, should be adequate, but for students of physical education it recommends an initial allowance of £55 and three annual grants of £65. For certain groups of one-year students it recommends a maximum grant for personal expenses at the rate appropriate to the first year of a two-year course, namely, £95. While for students who proceed directly to a supplementary course on completing their normal training, a maximum standard grant for personal expenses of £65 should be reasonable, for serving teachers the only satisfactory form of financial assistance is secondment on salary for the duration of their training, and general adoption of this practice is recommended.

It is clearly desirable that a system of standard grants for personal expenses should be accompanied by a uniform method of assessing parental contributions, and the working party finds in the income scale used for awards at universities made by the Ministry and by local education authorities a suitable general pattern for assessing a parent's capacity to contribute towards the cost of his children's education and training. Moreover, adoption of a single income scale for assessing grants for personal expenses would enable arrangements for both types of grant to be assimilated into a single scale, and the parental contribution would act in the first instance to reduce the amount of grant payable for personal expenses: a contribution towards boarding costs would fall due only when the assessed contribution exceeded the maximum of the grant for personal expenses. Under the scale, it would also become necessary for the

'home' local education authority to undertake the entire responsibility for assessment, and the working party points out that administration of this system of assessment would be simplified by adoption of a uniform standard boarding fee at all training colleges.

The total additional cost of these proposals, over and above the present annual expenditure on grants for personal expenses of £510,000, is estimated at about £1,400,000, of which £892,000 would fall on the Exchequer and £508,000 on local rates. The financial arrangements for teacher training as a whole would be simplified, and the working party also suggests including in the one pattern the personal and dependant's grants paid by the Ministry to some older one-year students, and also grants to day students towards the cost of their home keep while attending college, thus bringing the annual expenditure covered by the proposals to about £2,080,000.

BARLEY ROOTS: NITROGEN ASSIMILATION AND RESPIRATION

IT has already been shown that the respiration of barley seedlings is closely dependent on the supply of nitrogenous nutrients. In culture solutions containing ammonium salts or nitrates, barley seedlings show a rapid increase in carbon dioxide production, this being initially largely confined to the root system. The relation between respiration and the assimilation of nitrogen by roots has now been more fully explored by A. J. Willis and E. W. Yemm (*New Phytol.*, **54**, 2, 163 ; 1955). These investigators have presented and discussed a considerable series of observations and have reached the following conclusions.

The assimilation of nitrogen in excised roots of barley leads to high rates of respiration. The greatest respiratory increases are shown by roots deficient in nitrogen and rich in carbohydrate. Roots cut from seedlings which are grown under conditions of nitrogen deficiency and which have not exhausted their endosperm reserves show smaller carbon dioxide increases when external sources of nitrogen are supplied than roots from older seedlings. Increases in both carbon dioxide production and oxygen uptake result from treatment of roots with ammonium salts, nitrates, nitrites and hydroxylamine, although there are secondary toxic effects of hydroxylamine. The form of the respiratory response depends upon the source of nitrogen supplied : ammonium salts give rise to very rapid increases in gaseous exchanges, while with nitrate the greatest increases are not shown until about 9 hr. after its addition to the roots. The effects of other anions and cations supplied with the nitrogen source are small. At very low concentrations of the nitrogen supply the respiratory increase is limited, and all the available nitrogen is exhausted from the culture solution.

These effects of nitrogen compounds on respiration are different in form and magnitude from salt respiration. The salt respiration of roots grown under the conditions used here has been demonstrated to be very much smaller than the respiratory increases found on supplying the roots with inorganic nitrogen. Measurements of respiratory quotients and evidence from direct analysis indicate that nitrogen is rapidly metabolized in the roots, and that high rates of respiration are associated with the synthesis of nitrogen compounds in the tissues.

THE EFFECT OF CERTAIN DRYING CONDITIONS ON THE PUTREFACTION OF CATTLE HIDES AND GOATSKINS

IT is unfortunately true that, after flaying, African prepared hides and skins are left lying in heaps for an unnecessarily long time in wet and filthy conditions, and it is not surprising that putrefactive damage forms one of the more common blemishes of East African hides and skins.

Putrefactive damage can be diminished by measures which will decrease the bacterial population. One of the most effective ways of preserving hides and skins is to reduce their moisture-content to a level where bacterial action and growth become impossible. Air-drying is the most commonly used method of preservation in East Africa because (*a*) it is a quick, cheap and easy method for African conditions, (*b*) chemicals are not generally available for salting or pickling, (*c*) transport charges on dried hides and skins are lower than on salted or pickled stock, and (*d*) no special storage or transport facilities are required.

A series of experiments was carried out by Dr. R. L. Sykes to determine the extent to which putrefaction could be controlled by certain methods of drying (*Colonial Plant and Animal Products*, **4**, No. 3 ; 1954).

The traditional local African method of air-drying is to peg hides and skins on the ground, flesh-side up, to dry in the sun. The products, which in the past were called 'sun-drieds' and are now known as 'ground-drieds', are dirty, unattractive articles shunned by most tanners because, not only are they difficult to handle and soak back, but also because they give rise to unpredictable and serious losses during processing. Up to twenty-five years ago the bulk of East African hides and skins were prepared in this manner ; but, as the result of tests on drying procedures carried out by a few pioneers, certain tanners realized that, when dried in sheds, the resulting 'shade-drieds' possessed superior leather-producing values and gave significantly lower tannery losses. The difference was so outstanding that controlled tests were carried out in 1932 by the Imperial Institute and the Kenya Veterinary Department. These experiments confirmed the earlier tannery observations, and as a result the drying of hides and skins in open-sided sheds after suspension within a vertical rectangular frame was advocated.

From its 1932 tests the Imperial Institute drew the important conclusion that the essential factor in air-drying was suspension and not shade.

The 1932 trials also led the Imperial Institute to suggest that hides could be dried in the open provided the heat from the meridian sun could be tempered by orientating the plane of the hides in an east-to-west direction and by inclining it to the vertical so that the plane lay parallel to the rays of the midday sun.

It was not always easy to make uneducated producers understand what was required, and, since the midday sun in East African latitudes strikes a vertical plane obliquely, it was found more practicable to advocate vertical frames when drying hides in the open.

Neither this experimental evidence, nor the fact that many Uganda hides are so satisfactorily dried in the open in the wet season that tanners cannot

distinguish them from shed-dried articles, have convinced the more conservative critics, who are still doubtful whether drying in the open can ever be successful in moist humid climates. The experiments have shown that, under a variety of climatic conditions, some being most adverse, it is possible to dry cattle hides and goatskins satisfactorily. Provided the hides and skins are properly suspended for drying, the site, the presence of shade, or the method of suspension has little effect on the incidence of putrefactive damage. Similarly, under these conditions, a short delay of one hour in the cleaning, after flaying, has no effect on quality.

The majority of the putrefactive damage which occurs in hides and goatskins is avoidable and must be attributed to the carelessness or ignorance of the owner or producer. Any reasonably quick method of drying by suspension can thus be relied upon to eliminate putrefactive damage to hides and skins and no insuperable difficulty should be associated with normal drying methods in African reserves. This suggests a method by which a campaign for hides improvement, supported by the necessary legislation, should be able to develop the confidence of native producers and eliminate putrefactive damage almost completely.

REDUCTION OF CYTOTOXIC AZO COMPOUNDS BY HYDRAZINE AND BY THE XANTHINE OXIDASE–XANTHINE SYSTEM

By Dr. W. C. J. ROSS and G. P. WARWICK

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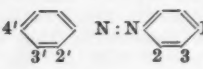
It has been shown[1] that many aryldi-2-halogenoalkylamines can inhibit tumour growth, provided that the compound contains halogen atoms of a certain level of chemical reactivity[2]. In attempts to obtain derivatives of greater selectivity of action, compounds have been prepared which have chlorine atoms of low chemical reactivity but which could be activated by a change in the molecule such as could readily occur *in vivo*. Derivatives of the azo-compound (I) are suitable compounds for trial, since the parent substances contain chlorine atoms of low reactivity, whereas reduction products (hydrazo-compounds or amines) would be more reactive. It was hoped that such reduction of the azo-linkage would occur in the organism—compare the reduction of 'Prontosil' to give sulphanilamide[3]—but that it would not take place equally well at all sites and that some measure of specificity of action would result.



(I)

A number of these azo-derivatives of 'aromatic nitrogen mustards' have already been described[4] and a long series of derivatives has now been prepared by us (unpublished work). Many of these compounds are effective inhibitors of the growth of the transplanted Walker rat carcinoma (personal communication by Prof. A. Haddow), and this suggested that the postulated reduction of the azo-linkage did, in fact, occur.

In order to obtain further evidence for the proposed mechanism of activation, an attempt has been made to correlate the ease of reduction of an azo-compound (I) with its biological activity. Since most of the compounds were sparingly soluble in water, the rates of reduction in 50 per cent aqueous alcohol at 24° C. and at *p*H 8 were initially investigated. Of the reducing agents examined, the most consistent results were obtained using hydrazine. The reaction, which was followed by measuring the characteristic light absorption at 400 mμ due to the azo-compound, was found to be first-order with respect to azo-compound, and in Table 1 the relative rates of reduction referred to the parent substance (I) are given. It can be seen that there is a definite indication that biological activity is associated with reducibility. Two apparent exceptions, the 2′-methyl- and 2′-carbomethoxy-derivatives, are almost certainly converted into the more readily reduced 2′-carboxy-derivative *in vivo*.

It was next felt desirable to ascertain whether any naturally occurring enzyme could effect the reduction of an azo-linkage; and since various dyestuffs are known to act as hydrogen acceptors in the xanthine oxidase–xanthine system, it seemed logical to examine this enzyme. In this case it was necessary to employ purely aqueous solutions, and accordingly the rates of reduction of various acidic derivatives, which have adequate water-solubility in pyrophosphate buffer at *p*H 8·2, were examined at 24° C. under anaerobic conditions. The suggestion to use this enzyme arose in discussions with Prof. F. Bergel, Mr. P. Avis and Mr. R. C. Bray, who kindly made available a concentrate of xanthine oxidase from cow's milk (stage *M5*) prepared as described by Avis *et al.*[5]. It was established that the azo-compounds

Table 1

Compound substituent(s) in (I)	Rate-constant for hydrazine reduction	Tumour-growth inhibitory activity
2-MeO,2′-COOH	617	+ ve
2-Me,2′-COOH	519	+ ve
2-Me,2′-COOH,4′-Me	512	+ ve
2-MeO	468	+ ve
2′-SO_3H	395	− ve
2-Me,4′-COOH	366	+ ve
2-Me	359	+ ve
2′-COOH	235	+ ve
2′ : 3′-benz	204	− ve
2′-Cl	193	− ve
2′-Me	187	+ ve
2′-Br	170	− ve
4′-SO_3H	146	− ve
4′-COOH	136	− ve
3′-COOH	126	− ve
3′-MeO	122	− ve
2′-COOMe	118	+ ve
3′-Me	109	− ve
3′-Cl	107	− ve
None	100	+ ve
4′-Cl	98	− ve
4′-Me	97	− ve
4′-Br	97	− ve
3′-Br	97	− ve
3′-NO_2	85	− ve

Table 2

Compound substituents in (I)	Per cent reduction by xanthine oxidase–xanthine at *p*H 8·2 in 30 min.	Tumour-growth inhibitory activity
2-COOH,4′-NO_2	*c.* 85 (in 5 min.)	+ ve
2-MeO,2′-COOH	70	+ ve
2-Me,2′-COOH	49	+ ve
2-Me,2′-COOH,4′-Me	42	+ ve
2′-COOH	34	+ ve
2-COOH,2′-CN	34	+ ve
4′-SO_3H	5	− ve
2-Me,4′-COOH	4	+ ve
4′-COOH	4	− ve
2′-SO_3H	2	− ve
3′-COOH	2	− ve

were unaffected by the enzyme alone or by xanthine alone under the standard conditions.

The correlation between reducibility and biological activity shown in Table 2 is even more striking. The rates of reaction are expressed in this instance as percentage reduction of the azo-linkage in a given time. One of the outstanding exceptions in Table 1—the 2′-sulphonic acid derivative—is now seen to be but slowly reduced by xanthine oxidase. The only anomaly in Table 2 is the 2-methyl-4′-carboxy-derivative, and here again it seems probable that oxidation of the methyl group to a carboxyl group will occur *in vivo*. It has, in fact, been shown that 55 per cent of the 2 : 4′-dicarboxy-derivative is reduced under the standard conditions.

The implication of a flavin–adenine–dinucleotide coenzyme in the *in vivo* reduction of azo-linkages has been discussed by Miller and Miller[6], and it is now suggested that xanthine oxidase may be the enzyme involved. It is realized that other dehydrogenases may be able to effect the reduction, and this point is under investigation. The protective action of dietary riboflavin in butter yellow carcinogenesis could be a consequence of increased xanthine oxidase activity which converts the dye into relatively inactive reduction products. Our *in vitro* experiments indicate an initial formation of hydrazo-compounds with both hydrazine and xanthine oxidase, since azo-compounds are re-formed on oxidation with iodine. Eventually this property is lost and, in the later stages of the reaction, fission of the molecule to give amines probably occurs.

If xanthine oxidase is the enzyme involved in the reduction of azo-compounds, it should be possible to increase the effectiveness of carcinogenic azo-dyes by simultaneous administration of known xanthine oxidase inhibitors, and also to increase the effectiveness of growth-inhibitory azo-'mustards' by suitably increasing the xanthine oxidase content of the tissues, for example, by increased riboflavin and protein intake. Those azo-compounds which are activated in the manner proposed should be particularly effective against neoplasms in which xanthine oxidase content is high, for example, in hepatomas[7]. It is hoped to test these points in the near future.

Full details of the preparation of the various azo-compounds and the reduction studies will shortly be published elsewhere.

This investigation was supported by grants to this Institute from the British Empire Cancer Campaign, the Jane Coffin Childs Memorial Fund for Medical Research, the Anna Fuller Fund, and the National Cancer Institute of the National Institutes of Health, U.S. Public Health Service, and was carried out during the tenure of an overseas C.S.I.R.O. research studentship by one of us (G. P. W.). We thank Prof. A. Haddow for permission to quote the results of tumour-growth inhibition studies, and Prof. F. Bergel for his interest in this work. [April 4

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OCCURRENCE OF TECHNETIUM-98 IN NATURE

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WE wish to present a preliminary report of results obtained in the course of a systematic search[1] for long-lived technetium-98[2] in terrestrial materials. This investigation was undertaken in an attempt to shed some light on the cosmological and astrophysical[3] problems raised by recent observations of technetium in the sun[4] and several stars of spectral types *S* and *M*[5].

In view of the expected low abundance[1] of the odd–odd nucleus ^{98}Tc, a highly sensitive method of detection, neutron activation analysis, was chosen. Upon exposure to slow neutrons, a sample containing technetium-98 will, by the (n,γ) process, yield technetium-99*m*, which can be readily identified by its 6-hr. half-life and 140-keV. γ-ray. The formation of this latter isotope may be regarded as proof of the presence of technetium-98, if its production by three alternative processes can be ruled out:

(1) $^{98}\mathrm{Mo}(n,\gamma)^{99}\mathrm{Mo}$, followed by $^{99}\mathrm{Mo} \rightarrow {}^{99m}\mathrm{Tc} + \beta^-$

(2) $^{98}\mathrm{Tc}(n,n')^{98m}\mathrm{Tc}$

(3) $^{98}\mathrm{Ru}(n,p)^{98m}\mathrm{Tc}$.

It is imperative for this reason that the concentrates to be isolated from selected minerals[1] be free of all traces of molybdenum, ruthenium and 2×10^6-year technetium-99. Since many other elements also interfere by the formation of γ-emitting activities, the following separation factors are required: Mo $\sim 4 \times 10^{10}$; Re $\sim 10^{10}$; Ru $\sim 10^6$; 59 other elements, 10^8–10^{11}.

A procedure meeting these requirements was developed by a combination of anion-exchange chromatographic and distillation techniques. The

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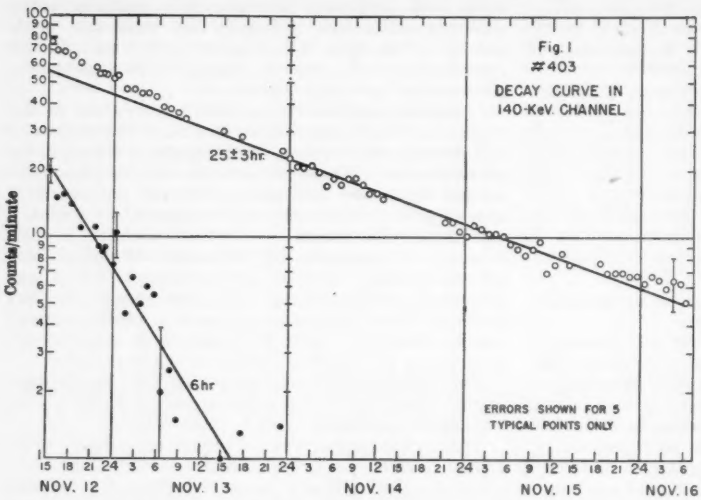

Fig. 1

minerals were dissolved by means of a fusion with sodium hydroxide and peroxide, and the sulphides of group II elements, along with any technetium present, were precipitated by hydrogen sulphide from acid solution. The sulphides were dissolved in a mixture of nitric, sulphuric and phosphoric acids, and the solutions steam-distilled under conditions in which technetium is known to be volatile. The distillate was then processed on 'Dowex-1' anion-exchange columns, and rhenium removed by elution with $0{\cdot}2f$ perchloric acid. The final concentrate, carried on copper sulphide or as mixed ammonium salts, weighing 0·1–1 mgm., was irradiated in the Brookhaven reactor for 12–70 hr. at a neutron flux of $(2{\cdot}4–3{\cdot}6) \times 10^{12}$ neutrons cm.$^{-2}$ sec.$^{-1}$. After irradiation, the copper was removed by cation exchange; the technetium, along with any molybdenum present, was co-precipitated with copper sulphide (procedure *A*), and counted with a scintillation spectrometer. In later work, the sample was processed on an anion-exchange column after the irradiation, and since technetium and molybdenum are separated in this step, a separate check for molybdenum was necessary. To accomplish this, the molybdenum was either carried on copper sulphide (procedure *B*), a method that was shown by separate tracer experiments to give a quantitative yield of molybdenum, or the molybdenum was carried on molybdenum sulphide (procedure *C*). In the latter case, a known amount of inactive molybdenum was added to the irradiated sample before any chemical processing, and the final yield of molybdenum determined by chemical analysis. By means of this last procedure, the formation of technetium-99*m* from molybdenum-99 could be ruled out with absolute certainty, provided the isotopic exchange between irradiated and non-irradiated molybdenum carrier was complete.

Of twelve samples examined thus far, six gave positive results and two gave negative results; in the remaining four cases the identification was uncertain. A summary of the results is given in Table 1; a typical decay curve is shown in Fig. 1. The data presented in Table 1 show that: (*a*) in all cases a contaminating activity such as zinc-69 or arsenic-76 formed through neutron capture by impurities from the resin and/or reagents makes a contribution to the counting-rate in the 140-keV. channel of the scintillation spectrometer; (*b*) contamination with molybdenum-99 makes a contribution to the observed technetium-99*m* activity in several experiments; but this contaminant was absent in five samples in which technetium-99*m* activity was definitely identified, and was not enough to account for all the technetium-99*m* observed in a sixth sample.

The latter statement depends upon the assumption that any molybdenum contamination present in these six runs behaved in the same manner as molybdenum tracer employed in experiments performed to check procedures *A*, *B* and *C*; this assumption is supported by the results in experiments 396 and 410. The levels of the other contaminating activities were generally sufficiently low to avoid any serious difficulty in the resolution of the composite decay curves.

In the first phase of this work it had to be established whether or not technetium-99*m* is produced by neutron activation of samples expected to contain technetium-98. The results obtained thus far have proved this beyond doubt, for both radiation and

Table 1. Summary of Neutron Activation Results

No.	Mineral and locality	Total activity in 140-keV. channel (counts/min.)	Technetium-99*m* observed (counts/min.)	Chemical procedure*	Growth from molybdenum-99	Conclusions
390	Columbite, Kal. Digirin, Somaliland	40	(< 4)	*A*	No	?
391	Columbite, British Guiana	56	10 ± 2	*A*	No	+
396	Columbite, Mtoko Dist., S. Rhodesia	7	5	*B*	Yes	−
397	Columbite, Galoleh, Henweina, Somaliland Prot.	12·9	10	*B*	No	+
402	Yttrotantalite, McCreedy's Tin Mine, Swaziland	56	7 ± 1	*A*	No	+
403	Yttrotantalite, Kelly's Tin Mine, Swaziland	77	21 ± 2	*A*	No	+
409	" " " "	52	33	*B*	No	+
425	" " " "	204	(22)	*C*	No	?
439	" " " "	122	(< 20)	*C*	No	−
440	Thortveitite, Norway	249	48	*C*	No	+
442	Yttrotantalite, Swaziland	122	78	*C*	?	?
443	Chromite, Gold Coast	71	33	*C*	?	?
410	Blank	3·9	2·2	*B*	Yes	

* Chemical procedures used after irradiation: (*A*) no separation of molybdenum and technetium carried out after irradiation; (*B*) molybdenum and technetium separated by anion exchange after irradiation; molybdenum recovered by copper sulphide precipitation; (*C*) molybdenum and technetium separated by anion exchange after irradiation; molybdenum recovered by molybdenum sulphide precipitation.

decay characteristics of the short-lived activity were repeatedly determined and found to agree very closely with those for technetium-99*m*. In the second phase, however, it had to be shown that the activity was produced by the (n,γ) reaction with technetium-98, and by no other process. We do not yet regard this phase of the work as completed, though the most plausible explanation of the internal consistency of the results suggests the presence of long-lived technetium-98. It is interesting to note that in a recent communication[6] Herr reports the detection of technetium-99*m* in the neutron activation analysis of a molybdenite; it is, however, not clear that the technetium-99*m* activity observed was formed from technetium-98; it may well have arisen from molybdenum-98 or technetium-99 contamination in the sample.

We are planning to carry out more neutron-activation analyses and to verify their results by independent methods such as mass spectrometry and emission spectroscopy. This work was supported in part by the U.S. Atomic Energy Commission. We hope to publish a detailed account of it in due course.

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THE CONTRACTILE VACUOLE OF PARAZOA AND PROTOZOA, AND THE GOLGI APPARATUS

By Prof. J. BRONTË GATENBY
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AND
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SAVILLE KENT[1] stated that "the peculiar flagellate sponge cells exhibited a very significant Protozoic feature in the possession of two or more posteriorly located, rhythmically pulsating contractile vesicles". In *Ephydatia* and *Spongilla*, Margaret Jepps[2] found contractile vacuoles in granular, hyaline, spicule-forming and collar cells, in the latter anteriorly located, however. Jepps studied various marine sponges, *Sycon*, *Grantia*, *Leuconia*, *Achinoe*, *Oscarella*, *Reniera* and *Halichondria*. She states, "In none of these sea sponges was a vacuole seen to contract in any cell whatever". Contractile vacuoles do, however, occur in some marine Protozoa.

Jan Hirschler[3], using the Kopsch and Sjövall methods (osmic acid reduction), described, as the Golgi apparatus of *Spongilla*, dictyosome-like bodies in the site of the contractile vacuole of Jepps. Hirschler did not know of the observation of Saville Kent, and thus unfortunately missed directing attention to the fact that the cortex of what seems to be the contractile vacuole in the freshwater sponge is specifically osmiophile, like the Golgi apparatus of the *Ciona* gut epithelium which he had studied at the same time by osmic methods.

It was left to D. Nassonow[4] to show that, in *Chilodon*, *Dogielella*, *Paramecium*, etc., the site of the contractile vacuole is the place of reduction of osmium tetroxide. Nassonow pointed out that in various metazoan cells (*Hydra*, *Axolotl*), a ring-form Golgi apparatus closely resembling the protozoan osmiophile ring-like surround of the contractile vacuole can be shown to exist. Nassonow considered that the cortex of the excretory apparatus of Protozoa, etc., was lipoid.

It has been shown by Dalton and Felix[5] that the metazoan Golgi apparatus typically consists of three components: (1) a group of long smooth double membranes; (2) clusters of small granules averaging about 400 A. in diameter, frequently showing an intimate association with the double membranes (these two components together form the cortical substance); and (3) a chain of large vacuoles arranged in the form of an open-sided cylinder. These vacuoles are not present in all cell types. The argentophily and osmiophily of the Golgi apparatus relate primarily to the small granules and the double membranes, although in some cells and under certain conditions the contents of the vacuoles are osmiophile.

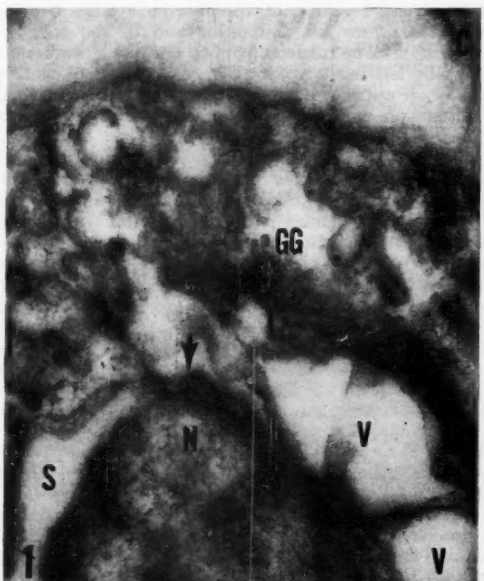

Fig. 1. Electron micrograph of the distal portion of a choanocyte of *Grantia* showing the base of the collar (*C*), part of the nucleus (*N*), shrinkage space (*S*), double membranes (arrow) and small granules of the Golgi complex (*GG*) and vacuoles (*V*). Approximately 30,000 ×

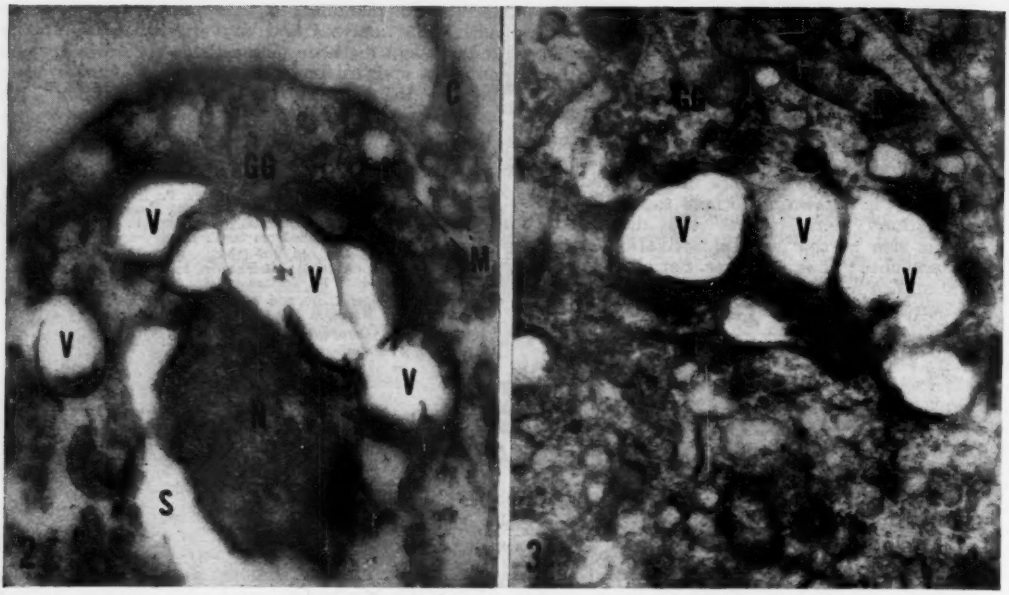

Fig. 2. Electron micrograph of a part of the same cell as in Fig. 1 at a different level, showing apparently separate vacuoles and mitochondria (*M*) with indistinct internal membranes. Other labels the same as in Fig. 1. Approximately 30,000 ×

Fig. 3. Electron micrograph of part of the Golgi zone of an epithelial cell of the epididymis of the mouse showing a marked similarity to the Golgi apparatus of the choanocyte (Fig. 1). The small granules appear to be continuous with the double membranes at some points (arrow). Labelling the same as in Fig. 2. Approximately 30,000 ×

The accompanying electron microscope photographs were made at Bethesda, Maryland (by A. J. D. and M. D. F.), from material fixed in buffered osmium tetroxide and chrome-osmium and received from Dublin (J. B. G.). Owing to the presence of spicules, the sectioning of the sponge material was very difficult. Figs. 1 and 2 of the marine sponge *Grantia compressa* show, at the outer end of the cell, the collar (*C*). The nucleus (*N*) has become shrunken on the left, leaving a space (*S*). Above the nucleus is the Golgi apparatus which, in the upper part of the photograph especially, shows a remarkable resemblance to the electron photographs of the epididymis (Fig. 3)[5,6]. There is a wall of double membranes and scanty Golgi granules (*GG*). In Fig. 2, we have confirmation of the observations of Jepps and Tuzet that several vacuoles can exist in this region. On the left of this figure, there is an apparently isolated vacuole (*V*) and at the lower right another partly shut off vacuole (*V*). At *GG* are examples of the scanty Golgi granules. At *M* are spherical mitochondria showing rather indistinct internal membranes. Besides the mitochondria, there are various granules of a smaller size of unknown nature. The Golgi apparatus of the choanocyte appears to have a spirally disposed inner cortical band.

We have also examined the contractile vacuoles of *Vorticella* sp. and the canals of the contractile vacuole of *Paramecium aurelia*. The osmic-reducing radiating canals are lined by a distinct, apparently single layer. Outside this, the osmiophile substance appears to be formed of a spongy branching network of short double membranes. Near the periphery of this zone are groups of small vacuoles. The cavity of the canal contains no formed material, and this also applies to the Golgi apparatus of the sponge *Grantia*. In the case of the contractile vacuole of *Vorticella* sp., the vacuole in partial systole contains a small cavity surrounded by a spongy mass of double membranes very similar to that of the cortex of the vacuole canal of *Paramecium*.

In conclusion, it can be stated that the electron photographs of the sponge Golgi apparatus closely resemble those of the metazoan cell Golgi apparatus. This point of similarity is further strengthened by the osmiophily of the cortical substance on both, the presence near both of the small Golgi granules, and by the primitive form of dictyokinesis which has been described in sponges, and in the contractile vacuole cortex of certain flagellates[7]. In 1933 Odette Tuzet[8] showed that the acrosome of *Reniera* is formed in contact with a spherical body identical with the invertebrate dictyosome: all other types of sponge cells studied with Golgi-apparatus methods by Tuzet had one or more typical dictyosomes arranged in cells as the contractile vacuoles drawn by Jepps. Thus from the freshwater sponge, through the marine sponge, we can link up the contractile vacuole and Golgi apparatus in metazoan cells. While the spongy cortical short branching material of the vorticellid contractile vacuole does not at first appear to resemble closely the lamellated membrane of the sponge, the substance of the cortical material in *Vorticella* is formed of double membranes; more work on other Protozoa may supply the necessary intermediate stages. A further account of this investigation is being published elsewhere. [March 1

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LETTERS TO THE EDITORS

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Erosion of Surfaces by Liquid Drops

THE question of erosion of aircraft surfaces due to flight at high speed in rain has for some time been the subject of study at research establishments both in Britain and in the United States.

To study the fundamental mechanics of the erosion process an apparatus is required which will reproduce the high-speed impact between a single drop and a surface. Due to the low relative speeds at which water drops shatter[1], difficulty is experienced in accelerating a water drop of the size occurring in rain to the speeds at which surface erosion occurs (above 400 ft./sec.). The alternative method of shooting the surface at a stationary drop has been used in an apparatus described below which has been developed at the Royal Aircraft Establishment.

A projectile, the flat nose of which forms the surface to be studied, is fired from a compressed-air gun at a drop of water suspended on a fine web composed of a solution of 'Perspex' in aniline. After striking the drop the projectile is decelerated in an energy-absorbing tube in such a way that the imprint of the drop on the surface is not damaged.

Fig. 1 is a diagram of the apparatus. The gun is fired by rapidly opening a valve actuated by a large-diameter piston. It has been found that accurate control of the projectile speed can be obtained by varying the air pressure in the gun, and speeds up to 800 ft./sec can be achieved. The technique of suspending the droplet was suggested by Mr. W. R. Lane, of the Chemical Defence Research Establishment, Porton, and provides a method of accurately placing a drop of any desired size. The energy-absorbing system comprises soft aluminium washers separated by spacers, the hole in the washers being larger in diameter than the flat impact surface of the projectile nose. The energy of the projectile is expended in passing through and deforming the washers. For some materials comprising the impact surface, such as metals, the washer system can be replaced by light pads of cotton wool, which do not damage the surface, placed at intervals along the tube.

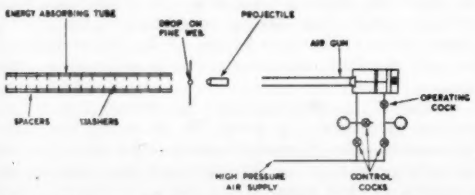

Fig. 1. Diagrammatic arrangement of apparatus. Crown copyright reserved

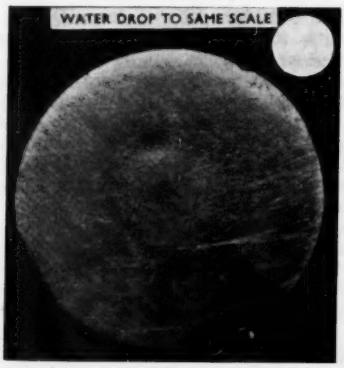

Fig. 2. Mark made in solid aluminium by a water drop, 2·5 mm. diameter, at 800 ft./sec. Crown copyright reserved

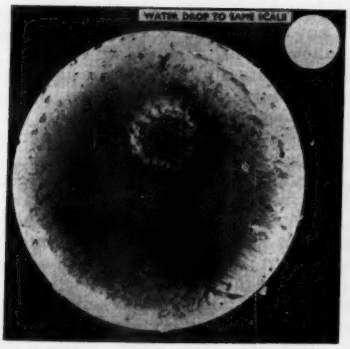

Fig. 3. Mark made in a wax layer by a water drop, 2·5 mm. diameter, at 580 ft./sec. Crown copyright reserved

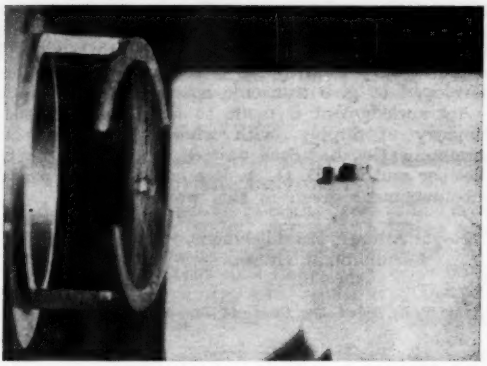

Fig. 4. Drop suspended on web. Crown copyright reserved

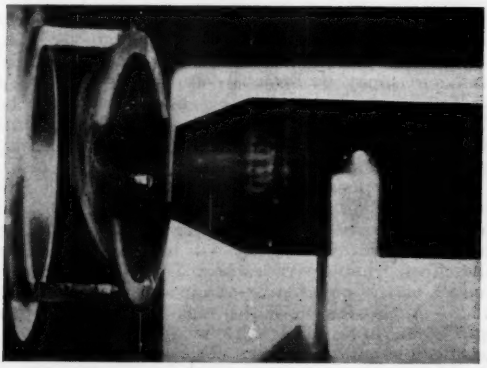

Fig. 5. Free drop before impact with projectile. Crown copyright reserved

Basic research with this apparatus is only about to start; but its possibilities are shown in the accompanying photographs, Figs. 2, 3, 4 and 5. Fig. 2 shows the impression made in solid aluminium by a 2·5 mm. diameter drop at 800 ft./sec., the depth of impression being approximately 1/1,000 in. Fig. 3 shows the annular crater made by a 2·5 mm. diameter drop in wax at 580 ft./sec.

Figs. 4 and 5 show how the air preceding the projectile blows the web away, leaving a roughly spherical drop to be struck by the projectile. Fig. 4 shows the drop suspended on the web and Fig. 5 the web being blown away. The projectile speed in this instance was 770 ft./sec.

Apart from the study of impressions of water drops on various surfaces other liquids can be tried; small drops of mercury have been successfully used. Another development proposed is to fit a piezo-electric crystal in the nose of the projectile to study impact forces and pressures. It may also be possible to study the effect of shock waves on water droplets and to investigate further the droplet break-up processes at very high speeds if the apparatus can be developed to give transonic speeds.

Acknowledgment is made to the Chief Scientist, Ministry of Supply, with whose permission this communication has been written, and to Mr. W. C. Clothier and Mr. D. G. A. Rendel for the help and encouragement given in this work.

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A Fluctuating Celestial Radio Source at 242 Megacycles per Second

During our recent radio mapping survey at 242 Mc./sec. of the region near the antigalactic centre, we have detected a fluctuating radio source. The fluctuations appear similar to the scintillations observed at lower frequencies as caused by the ionosphere[1]. No scintillation or fluctuation effect had been observed by us on any source in all our previous observing at or near 242 Mc./sec. Accordingly, this source was regarded with great interest, since it appeared likely that scintillations at this frequency and at a high altitude (about 60°) might mean that the source was of very small angular extent, or at least smaller than the sources having scintillation at lower frequencies and smaller than any other source we have detected. In other words, the source may be of stellar dimensions, that is, a true radio star. Although the fluctuations may be due to scintillations, there is also evidence that the fluctuations may represent variations in the intensity of the source itself.

Since the phenomenon may be caused by either scintillations (of ionospheric or tropospheric origin) or by true variations in intensity of the source, or both, the term 'fluctuation' will be used to describe the effect, whatever its cause. The first fluctuation record of the object was obtained on January 22, 1955. A photograph of this record is shown by the upper trace in Fig. 1. It is to be noted that the peaks of the fluctuations clearly outline the envelope of the antenna pattern. The source was again detected as a slight rise but without the marked fluctuation

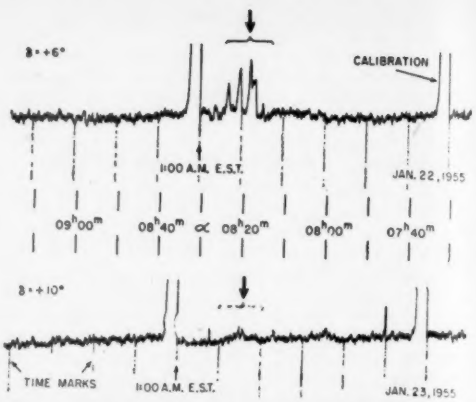

Fig. 1. Signatures obtained with the 96-helix Ohio State University radio telescope in which a source with marked fluctuations appears on January 22, 1955, but on the next night as a slight rise. The position of the source is indicated by the heavy arrows. The antenna has a fan beam 1·3° wide in right ascension by 8° in declination

effect on January 23, 1955. A photograph of this record is shown by the lower trace in Fig. 1. The large deflexions appearing on the records at 1.00 a.m. are calibrations impressed automatically once each hour. The marks extending below the traces at 10-min. intervals are time marks impressed automatically from *WWV* time signals at the beginning of each 600 c./s. tone interval. The horizontal co-ordinate is right ascension (α) (1950.0).

Our observations of the source were interrupted after January 23 by a routine survey, but during April and May of this year the source has been re-observed. A total of fourteen good records of the source have now been obtained with the following results: on January 22, April 17, April 30 and May 11, 1955, the source shows marked fluctuations, whereas on December 9, 1954, January 23, April 14, 15, 16, 20, 27, and May 9, 10 and 15, 1955, the source shows only as a slight rise.

Without the fluctuations the source has an intensity of about 1×10^{-25} W. m.$^{-2}$ (c./s.)$^{-1}$. With fluctuations the intensity increases for short periods by a factor of 6 or so. The marked fluctuations have a period of 2–3 min.

Owing to the weakness of the source and its fluctuating nature, it is difficult to determine its position accurately. Our present best position (1950.0) is: R.A. 08h. 19m. ± 1m.; Dec. +8° ±3°. This is close to the source reported in our list of 207 sources[2] as Hydra *P*.

It was mentioned that there are some factors in favour of the interpretation that the fluctuations are intrinsic variations in the source and not scintillations. These are: (1) marked fluctuations have been observed near midnight and also near sunset; this result cannot be correlated with the usual diurnal variation observed in scintillations; (2) marked fluctuations have never been observed on two consecutive days, or in fact at a more frequent interval than 11 days; (3) it has not been possible to establish any correlation between the marked fluctuations and any solar or ionospheric phenomena; (4) very occasionally, large peaks in intensity are observed that resemble solar bursts.

If the fluctuations are intrinsic variations in the source, an explanation is that the source is a star

with variable radio emission having a period of hours or days and also a short period of a few minutes. Of course, the fluctuations may be due to both scintillations and variability, in which case the short-period fluctuations may be true scintillations that are observed only when the source is at or near maximum intensity and the ionospheric conditions are also suitable.

Whatever the explanation, the observations suggest that the source may be a true star or a new class of radio object. Attempts to identify the source with an optical object have not yet been successful. More observations are needed to improve the accuracy of the position and to follow the fluctuation periods. Unfortunately, this source is observable now only during the day at times at which severe radio interference is encountered on most days. Accordingly, more detailed observations may have to wait until the source is again in a favourable observing position.

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Liquid Immiscibility in a Silicate Melt

The formation of immiscible liquids in silicate melts has been suggested as one of the possible methods by which natural magmas may produce a variety of rock types. This theory has, however, not found much favour among petrologists, because of the lack of observational and experimental evidence. Bowen[1] pointed out that direct evidence of this phenomenon, if it existed in rock melts, should be found in glassy lavas such as obsidian; in these lavas would be found discrete spheres of one glass embedded in another glass of different composition. No such phenomena have been observed. Greig[2] conducted extensive laboratory investigations on immiscibility in binary and ternary silicate systems. The areas of liquid immiscibility which he found lay well away from those representing even abnormal rock compositions. More recently, however, Roedder[3] found an extensive region of low-temperature immiscibility in the system $FeO—K_2O—Al_2O_3—SiO_2$. This new region of immiscibility fell much closer to the compositions of some abnormal rock types. Direct evidence of the existence of silicate immiscibility in Nature has still been lacking, however.

In a recent study of tektites directed towards a theory of their origin, we considered the possibility that the so-called 'lechatelierite' inclusions frequently reported in these glassy bodies might really represent liquid immiscibility. This idea is not original; it has been put forward, but for various reasons discarded, by Barnes[4].

A series of experiments using the quenching method was carried out on an artificial mixture of soda, lime, magnesia, alumina and silica approximating in composition to an iron-free tektite. Certain quenched charges consisted of small spheres of one glass embedded in much larger quantities of a second glass, thus giving evidence of immiscibility in the liquid state. This prompted a further test on actual tektite material sealed in a platinum envelope in a small evacuated silica tube to prevent oxidation of the ferrous iron. The quenched sample again showed the same phenomenon—small spheres of glass embedded in the greater mass of glass of slightly higher refractive index. The phase represented by the spheres made up something less than one per cent of the whole.

From this evidence we conclude that the so-called 'lechatelierite' inclusions in tektites most probably represent a state of liquid immiscibility in a silicate melt. It appears to be the only evidence of this phenomenon yet found in Nature.

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Observations of Spiral Growth Steps in Ethylene Polymer

The role of dislocations in crystal growth has been discussed by N. F. Mott[1], and later, evidence was given by Griffin[2] to support the mechanism suggested by Frank[3]. Since that time there has been striking examples of this type of growth, described by Dawson and Vand[4], and Forty[5] along with Verma[6], to mention a few.

No report, however, seems to have appeared indicating that growth by a dislocation mechanism can take place in a polymer. All evidence of crystallization of polymers seems to be of a different character.

Recently, growth by a dislocation mechanism has been observed in 'Marlex 20*' (trade name of Phillips Petroleum Co.), a predominantly polymethylene structure with limited branching along the polymer chain. Preliminary work indicates the distribution of molecular weights to be approximately linear from 2,000 to 28,000, with a mean molecular weight of 10,000. These small crystals were grown from hot solution in xylene, were shadow cast[7] ($\measuredangle$ 2 : 1) and examined

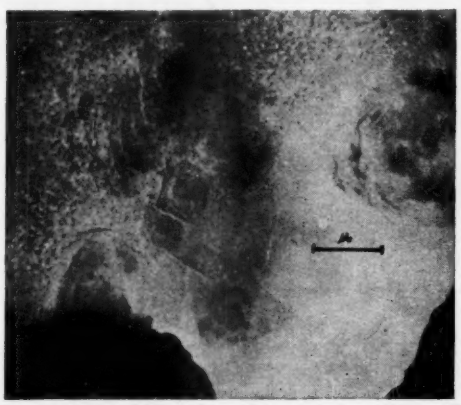

Fig. 1

in the electron microscope. Spiral growth was evident in numerous specimens obtained from both hot xylene and benzene solutions. Fig. 1 illustrates one of the simplest examples of this growth, showing growth from a single spiral. Generally, more complicated effects are observed due to the impingement of growth layers. In larger aggregates, the lozenge shape seems to persist.

I wish to thank the Phillips Petroleum Co. for their specimen.

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Reduction in X-ray Sensitivity of Seeds by Hydration

Numerous investigators have reported that when seeds are soaked there is a parallel increase in their water content and sensitivity to X-rays[1]. These studies have been taken as strong support for the postulate that much radiation injury results 'indirectly' from the decomposition and/or ionization of water. Therefore, it was of some concern to us when it was shown there was actually an inverse relationship between the water content of dormant barley seeds and their sensitivity to X-rays[2]. For this reason it seemed desirable to re-investigate the relation between radiosensitivity and the water content of soaked seeds.

Dormant seeds, originally stored over phosphorus pentoxide until they reached weight equilibrium, were soaked at 0° C. and 22° C. for different periods of time and then subjected to X-rays. They were grown for seven days and the average heights of the seedlings compared with those of irradiated unsoaked seeds (Fig. 1).

From these results it is clear that the sensitivity of seeds to X-rays decreases after one hour of soaking at 22° C. However, after four hours soaking they are about as sensitive as dry controls. In contrast to this, when soaked at 0° C. the seeds slowly increase in resistance to X-rays, so that after four hours they reach a point of maximum resistance comparable to that obtained after one hour soaking at 22° C. They maintain this level of tolerance when the soaking period is extended up to eight hours. However, further soaking results in a gradual increase in sensitivity and after 24 hr. they are about as sensitive to X-rays as the dry control. It is significant that the embryo rapidly absorbs water, and the water content of embryos of seeds soaked at both temperatures for one hour equals about 40 per cent of their wet weight. After 24 hr. soaking it only increased to about 60 per cent. The corresponding water content of the embryo of the dry control was 4 per cent.

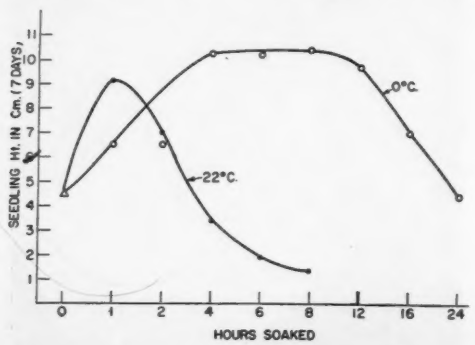

Fig. 1. Effects of soaking barley seeds at 22° C. and 0° C. on their sensitivity to 15,000 r. of X-rays

Two points seem clear from this work: (1) the X-ray sensitivity of dry seeds can actually be decreased by periods of soaking at both 0° C. and 22° C.; (2) the duration of the reduced sensitivity is related to the temperature of the steeping water and is probably associated with increased physiological activity.

These results suggest that the radio-decomposition of water may play a less significant part in modifying radiosensitivity than has previously been assigned to it.

Part of this work was carried out at Brookhaven National Laboratory under the auspices of the U.S. Atomic Energy Commission.

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and the
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Distribution of Radiocarbon in Tobacco Mosaic Virus

We have made radioactive tobacco mosaic virus by exposing leaves from infected tobacco plants to radioactive carbon dioxide for one day in light, treating the homogenized leaves with buffer solution, and purifying the virus by repeated precipitation at the isoelectric point[1]. The virus is determined by colour reaction, burned, and the radioactivity of the resulting carbon dioxide measured with a gas Geiger counter[2]. It has been found that the specific radioactivity (activity per unit weight) of the virus decreases with increasing 'age', that is, with increasing time-interval between infection and radiophotosynthesis, up to an age of about four weeks[3,4]. In addition, one sample of tobacco mosaic virus, aged two months, was analysed for distribution of radioactivity. The nucleic acid was split off by treatment with trichloroacetic acid[5], and the protein hydrolysed and divided into the individual amino-acids by column chromatography[6]. A large part of the radiocarbon was found in the nucleic acid, and the distribution of the radiocarbon among the individual amino-acids was quite uneven[7].

Using the methods described, we have now determined the distribution of the radiocarbon between nucleic acid and protein as a function of age of the virus. The samples of tobacco mosaic virus were the same as those used in the previous work[4]. The seeds had been sown in March, the plants transferred to the open field in May, and infected (first series; *A*) early in July, or (second series; *B*) late

in August. For the purpose of Tables 1 and 2, all results have been combined, as no significant differences between the two series appeared. The sample marks in the first vertical column of Table 1 establish the connexion with the previous paper, where further data on the samples are found[4]. The activity values listed in Table 1 are the actual numbers of disintegrations per minute. Where the sum of the activities of the protein and the nucleic acid (columns 4 and 5) does not fully agree with the activity of the tobacco mosaic virus, as measured independently (column 3), the percentages are referred to the sum. For clarity, mean values of the percentages are given in Table 2.

Table 1. Activities of Tobacco Mosaic Virus Protein and Nucleic Acid

Sample	Age (weeks)	Activities (disintegrations/min.)		
		Tobacco mosaic virus	Protein component	Nucleic acid component
A 1	1	2,050	400 (20 per cent)	1,650 (80 per cent)
A 2	1	2,900	300 (14 ,,)	1,850 (86 ,,)
A 4	2	13,800	5,550 (37 ,,)	9,550 (63 ,,)
B 1	2	1,950	500 (25 ,,)	1,550 (75 ,,)
B 2	2	9,400	3,600 (42 ,,)	5,050 (58 ,,)
A 5	3	3,700	2,200 (60 ,,)	1,500 (40 ,,)
B 3	3	2,900	1,850 (55 ,,)	1,550 (45 ,,)
B 4	3	8,800	5,100 (65 ,,)	2,750 (35 ,,)
A 7	4	3,850	1,600 (39 ,,)	2,450 (61 ,,)
B 8	5	59,500	17,000 (32 ,,)	35,200 (68 ,,)
A 11	6	7,700	4,650 (69 ,,)	2,100 (31 ,,)
A 12	6	2,950	1,400 (48 ,,)	1,500 (52 ,,)
A 18	9	15,600	9,150 (65 ,,)	4,950 (35 ,,)
A 21	11	34,600	24,000 (66 ,,)	12,100 (34 ,,)
A 22	11	24,700	15,700 (65 ,,)	8,550 (35 ,,)

Table 2. Mean Values

Age (weeks)	Per cent activity in	
	Protein	Nucleic acid
1	17	83
2	35	65
3–4	55	45
5–6	50	50
9–11	65	35

In spite of the large fluctuations of individual values (Table 1) it is clear from Table 2 that, in general, the fractional radiocarbon content of protein increases greatly with age of the virus. Thus young virus, which is still growing rapidly, directs radiocarbon (that is, carbon newly introduced into the leaf) relatively more efficiently into the nucleic acid than does old virus.

Tobacco mosaic virus contains 50 per cent carbon; but its nucleic acid (5·6 per cent of the weight of virus) has 36 per cent carbon only[8]. Hence the quantity of carbon in the protein is 24 times greater than that in the nucleic acid. Applying this figure to the data of Table 2, one finds that in tobacco mosaic virus one week old the specific activity of the nucleic acid carbon is about 115 times larger than that of the protein carbon, but in virus about ten weeks old only 13 times larger.

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Inhibition by Cyanide of the Photochemical Activity of Isolated Chloroplasts

Cyanide is an effective inhibitor of the photosynthesis of most plants. Photosynthesis in weak light is relatively insensitive to cyanide, whereas studies with flashing light show that cyanide does not affect the yield of oxygen from each light flash if the dark time between flashes is made long enough. Experiments of this type, together with other lines of evidence, all indicate that the cyanide-sensitive phase of photosynthesis is the primary reaction in the fixation of carbon dioxide[1]. It should not be concluded, however, that all the other reactions in photosynthesis are insensitive to cyanide. The apparent lack of sensitivity of other reactions may result simply from a low concentration of the carboxylating enzyme system relative to other enzymes. Under such conditions, cyanide would appear to be selective for the carbon dioxide fixation process[1].

It was not possible to examine directly the effect of cyanide on any of the other reactions of photosynthesis until the discovery by R. Hill[2] that isolated chloroplasts could split water with the formation of hydrogen ions and oxygen gas upon illumination in the presence of a suitable electron acceptor (oxidant). This reaction (the Hill reaction) is generally regarded as representing the oxygen-evolution part of photosynthesis. The Hill reaction, in confirmation of the picture based on studies of photosynthesis, has been reported to be insensitive to cyanide[3], although Macdowall[4] observed 15–20 per cent inhibition with 0·01 *M* potassium cyanide. Recent

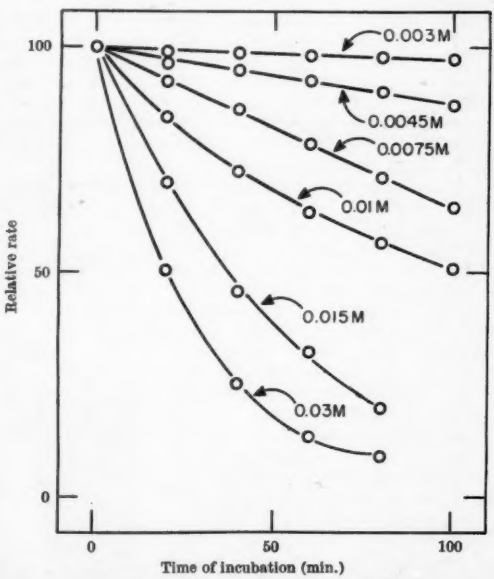

Fig. 1. Progressive inhibition of the Hill reaction by potassium cyanide. Rates are relative to uninhibited controls. Isolated chloroplast fragments were incubated with cyanide in sealed tubes at 2° C., and Hill reaction activities were measured potentiometrically (ref. 6) at the times shown at 10° C., with 0·0005 *M* potassium ferricyanide as the oxidant

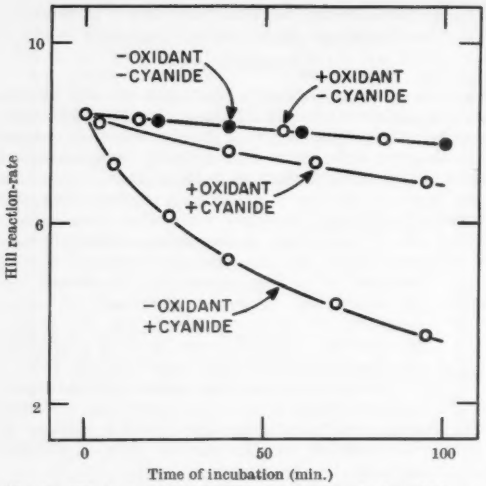

Fig. 2. Effect of oxidant (0·0015 *M* potassium ferricyanide) on the inhibition of the Hill reaction by 0·01 *M* potassium cyanide. General reaction conditions were the same as in Fig. 1. Rates are expressed as m.moles ferricyanide reduced/hr./mgm. chlorophyll

work in this laboratory, however, indicates that the Hill reaction is more sensitive to cyanide than has been previously reported if examined under certain conditions.

Chloroplast fragments from rhubarb chard and sugar beet (*Beta vulgaris*), prepared and stored in a potassium chloride – sucrose medium as previously described[5], were incubated at 2° C. in sealed tubes at *p*H 6·8 in the presence of different concentrations of potassium cyanide. At intervals, 1-ml. samples were removed and the Hill reaction activity was measured at 10° C. by a potentiometric method[6]. Similar results were obtained with the usual manometric technique. The results from a typical experiment of this type are given in Fig. 1. As the curves show, cyanide is a rather effective inhibitor. It demonstrates a very definite progressive effect, however, in that the degree of inhibition increases with time. Maximum inhibition is attained only after prolonged contact with the chloroplast fragments.

These results were contrary to earlier studies made in this laboratory using a standard technique in which the oxidant and the inhibitor (cyanide) were mixed before the chloroplasts were added. Under these conditions, cyanide produced only slight inhibition even at concentrations greater than 0·01 *M*. This indicated that the oxidant had some effect on the inhibitory action of the cyanide. Cyanide inhibition was then studied with and without the presence of oxidant during the incubation period. The results of a typical experiment of this type are given in Fig. 2. The curves clearly show that no appreciable inhibition by cyanide develops in the presence of the oxidant. These observations, together with the progressive time-effect described above, might very well account for the lack of inhibition of the Hill reaction by cyanide reported by other workers.

The mechanism by which cyanide inhibits the Hill reaction activity of chloroplast fragments is not known. Experiments now in progress indicate that both the light and the dark rate-limiting processes[7] are affected by cyanide. However, the light-reaction appears to be considerably more sensitive than the dark-reaction. It should be pointed out that the apparent cyanide inhibition described above could be interpreted in terms of an acceleration of the chloroplast inactivation reactions by the cyanide.

This work was supported by grants from the United States Atomic Energy Commission and the University of Utah research fund.

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March 10.

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A New Type of Plant Growth-regulating Substances

In the course of systematic investigations of the dithiocarbamates, the compound S-(carboxymethyl)-dimethyldithiocarbamate,

$$(CH_3)_2N{-}C(=S){-}S{-}CH_2COOH$$

(I)

obtained by the reaction of sodium dimethyldithiocarbamate with monochloroacetic acid, was found to exhibit distinct plant growth-regulating activity. Tomato plants, about 20 cm. high, from which the tip was replaced by a glass tube containing a 1,000 p.p.m. solution of this compound showed very clear epinastic curvature and leaf deformations (Fig. 1)

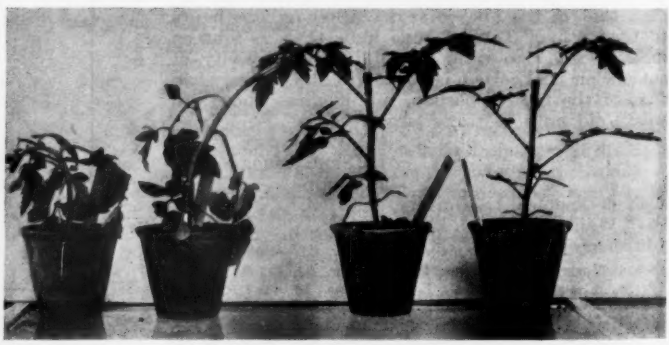


Fig. 1. *Left:* Two tomato plants the stem tips of which have been replaced by a glass tube containing a 1,000 p.p.m. solution of S-(carboxymethyl)-dimethyldithiocarbamate (compound I). Photographed after one day.

Right: Two tomato plants which were treated in the same way with water

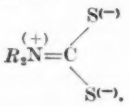
which were of the same type as those caused by 2,4-dichlorophenoxyacetic acid.

Growth responses, especially curvatures, and slight deformations of leaves resembling those brought about by synthetic growth substances were also found after application of the compound to cucumber and pea plants. When applied to the soil of potted plants a similar picture was obtained, indicating a translocation of the active substance within the plants. Activity could also be shown on root initiation of tomato and *Phaseolus*.

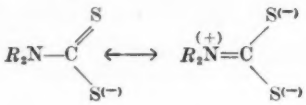
In the Went pea test, the compound had an activity of 1 per cent, in the *Avena* cylinder test and also in the sunflower stem test[1] the activity was about 5 per cent of that of indole-3-acetic acid. Its activity in the classical *Avena* curvature test was very weak.

These observations seem to conflict with the first of the now generally recognized structural requirements for plant growth-regulating activity, namely, the presence in an active compound of a basal ring system with high surface activity (cf. ref. 2).

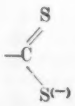
Some years ago, when investigating the relation between chemical structure and antifungal activity in the series of the dialkyl dithiocarbamates[3], arguments were brought forward for the view that the high and specific antifungal activity of the lower dialkyldithiocarbamates depends on the occurrence of the chemical structure



It was assumed that this structure can only be formed if in the system

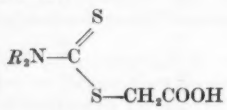


the nitrogen atom in the dialkyldithiocarbamate ion is aided in its mesomeric electron release to the



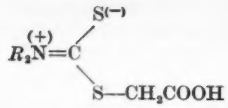
group. This aiding effect is maximal for the methyl group and quickly diminishes if R is replaced by higher alkyl groups. Thus, what happens is that the N—C bond in the dialkyldithiocarbamate ion acquires a certain amount of double-bond character under the influence of electron-releasing substituents R.

Returning to the plant growth-regulating properties of compound I, it is tempting to suggest that activity in the series



(II)

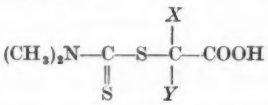
is again connected with the possibility that the N—C bond acquires a double-bond character as a consequence of similar internal electron shifts:



In this way a 'ring' system bearing a polar side-chain in a distinct spatial position as required for growth-regulating activity is formed.

In view of the earlier work outlined above, it might be expected that replacement of R = methyl in compound (II) by higher alkyl groups would quickly lead to compounds without plant growth-regulating activity. In fact it was found that already S-(carboxymethyl)-diethyldithiocarbamate ($R = C_2H_5$) is much less active.

In connexion with the observations of Wain[4] regarding the influence of side-chain substitution on growth-regulating activity in the series of the aryloxyalkylcarboxylic acids, the effect of replacement by alkyl groups of one or both hydrogen atoms in the CH_2-group of compound I was investigated. In accordance with his results, it was found that growth-regulating activity in the series



is observed only if at least one of the substituting groups X and Y is hydrogen. Further, it has been observed that replacement of C=S in compound I by C=O results in loss of growth-regulating activity. Activity is maintained, however, if the sulphur atom in the group C—S—C is replaced by oxygen.

Table 1 summarizes our observations on the growth-regulating properties of the dithiocarbamate derivatives under consideration.

Table 1. Plant Growth-regulating Properties of a Number of Dithiocarbamate Derivatives

$(R_1)_2N—C(=S)—S—C(R_3)(R_4)—COOH$	Results obtained in the tomato leaf epinasty test, the Went pea test, the *Avena* cylinder test and in the sunflower stem test
$R_1 = CH_3$ $R_2 = R_3 = H$	Active
$R_1 = C_2H_5$ or higher alkyl groups $R_2 = R_3 = H$	Slightly active or inactive
$R_1 = CH_3$ $R_2 = CH_3$ $R_3 = H$	Active
$R_1 = CH_3$ $R_2 = C_2H_5$ $R_3 = H$	Active
$R_1 = CH_3$ $R_2 = R_3 = CH_3$	Inactive
$(CH_3)_2N—C(=S)—S—CH_2COOH$	Slightly active or inactive
$(CH_3)_2N—C(=O)—O—CH_2COOH$	Active

With regard to the side-chain bearing the polar group, the compounds listed follow the activity pattern already known for other synthetic growth-regulating substances. The interesting new feature observed with these compounds seems to be that the electron shifts caused by simple substitutions in the remaining part of the molecule may, or may not, lead to the specific spatial arrangements required for growth-regulating activity.

The activity of the ethyl esters followed the same line as that of the corresponding free acids.

A fuller account of this work will be published elsewhere.

We are indebted to C. W. Pluygers for synthesizing the chemical compounds, and to G. Meyer for carrying out a number of biological tests.

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Basophilia and High Ribonucleic Acid Content of Dividing *E. coli* Cells

In a previous communication[1], a staining technique was described for demonstrating the wide difference in basophilia of growing and non-growing cells of *E. coli*. The high basophilia of growing *E. coli* cells has been attributed by Belosersky[2] to the presence of pentose nucleic acid which is not attached to protein. Apart from the work of Belosersky and his collaborators, the nature of the additional ribonucleic acid has received little attention, although it has been known for some years that rapidly growing and dividing cells of bacteria have a substantially higher concentration of ribonucleic acid than resting cells, and there is ample evidence of the heterogeneity of ribonucleic acid in metazoan cells[3].

To characterize the additional ribonucleic acid in dividing cells of *E. coli* (N.C.T.C. No. 1100) and to determine whether or not it reflects a general increase in the existing complement of constituents containing ribonucleic acid of the cell, the ribonucleic acid of rapidly dividing cells and resting cells of this bacterium were subjected to various fractionations. Dividing cells were obtained from a casein/casein/yeast culture[4] during the phase of maximum growth and of rate of division; resting cells were obtained from a fully grown culture.

When disintegrates of these cells were fractionated by centrifugation, it was found that the basophilia of dividing cells was located in the deposit obtained between 25,000 *g* and 100,000 *g*. Chemical analyses revealed that the ribonucleic acid in this fraction exceeded that in the corresponding fraction from resting cells by the difference in the total ribonucleic acid concentration of the unfractionated dividing and resting cells. The coincidence of the additional ribonucleic acid and the basophilia in one fraction lends support to Belosersky's contention that ribonucleic acid is responsible for the high basophilia of these cells. However, the possible heterogeneity of this fraction has not been investigated, and it is not known whether the ribonucleic acid responsible is attached to protein or not. The ribonucleic acid content of the basophilic fraction was approximately 40 per cent ribonucleic acid nitrogen/total nitrogen. This figure was calculated from a determination of the acid-insoluble pentose as determined by Militzer[5] and the ribonucleotide ratio of the whole ribonucleic acid of the cell.

The finding of basophilic and ribonucleic acid-rich particles in dividing bacterial cells is of particular interest in view of the discovery by Petermann *et al.*[6,7] of similar submicroscopic particles in chick embryo, regenerating liver and tumours which they detected in the analytical centrifuge at 95,000 *g* and believe to be rich in ribonucleic acid. In regenerating liver, Petermann[6] was able to correlate the high concentration of these particles with rapid cell division.

The identification of the ribonucleic acid-rich particles from dividing *E. coli* cells with those from dividing metazoan cells would support the suggestion made previously[8] that the additional ribonucleic acid of dividing and growing *E. coli* cells is more directly concerned in the division process than the growth process.

Acknowledgment is made to the Chief Scientist, Ministry of Supply, for permission to publish this communication.

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Anaerobic Metabolism of Thiocyanate by Thiobacilli

In 1904, Beijerinck[1] first described the decomposition of ammonium thiocyanate by Thiobacilli. Thirty-three years later, Happold and Key[2] reported the disappearance of thiocyanate from gas liquors due to microbial activity. The thiocyanate-oxidizing organism was only obtained in pure culture by Happold, Johnstone and Rogers[3] in 1952. In a subsequent publication, Happold, Johnstone, Rogers and Youatt[4] characterized the organism finally as a strict autotroph which aerobically oxidized thiocyanate to sulphate, carbon dioxide and ammonia. The organism grew with carbon dioxide as sole source of carbon, and could derive its energy from the oxidation of sulphur and thiosulphate with oxygen as oxidant. The name *Thiobacillus thiocyanoxidans* was suggested.

The oxidation of thiocyanate by Thiobacilli under anaerobic conditions with nitrate as oxidant was discovered in this laboratory some months ago. It was found that certain strains of *Thiobacillus denitrificans* isolated from surface water and from corroded sewer concrete were capable of oxidizing thiocyanate with the production of gaseous nitrogen. Strains *A*3-1 and VI*b*-1, two of six pure cultures examined, when

cultivated in a medium containing 0·1 per cent ammonium thiocyanate, 0·05 per cent ammonium chloride, 0·02 per cent potassium dihydrogen phosphate, 0·1 per cent sodium bicarbonate, 0·1 per cent potassium nitrate (*p*H 7) in Struyk tubes, invariably produced gas within a period of two to three weeks.

Enrichments with surface water containing 0·1 per cent ammonium thiocyanate, 0·1 per cent potassium nitrate, 0·05 per cent ammonium chloride and 0·1 per cent sodium bicarbonate similarly showed denitrification with the disappearance of thiocyanate. Gas production was, however, much slower than in corresponding enrichments containing thiosulphate. The adaptation of other Thiobacilli to thiocyanate was also studied. Two locally isolated pure cultures of *Thiobacillus thioparus* grew well in an autotrophic medium containing 0·05 per cent sodium thiosulphate and 0·05 per cent thiocyanate. In a medium containing 0·05 per cent ammonium thiocyanate as sole oxidizable source of sulphur, no macroscopically visible growth occurred, however, although the cells remained viable.

Further study of this subject is in progress and will be published elsewhere. This communication is published by permission of the South African Council for Scientific and Industrial Research.

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Deoxyribonucleic Acid Content of the Nucleus and Nuclear Volume

IT seems of interest to analyse if, in a given species, there is any relationship between the volume of the cell-nuclei and their deoxyribonucleic acid (DNA)-content. Except within the same tissue, H. H. Swift[1] denies the existence of such a relationship. Recent findings by G. Marinone[2] in cells of different nature in hæmatopoietic organs are in agreement with this view. C. Leuchtenberger and F. Schrader[3], however, conclude that even in the same organ—the liver of the white rat—no direct relationship exists between the nuclear volume and the DNA-content.

We have now undertaken the determination, by the histophotometric technique of L. Lison[4], of the DNA-content of the liver-cells in the white rat under different experimental conditions, to re-investigate the problem of the DNA-content/volume relationship within this tissue. The nuclei of the three classes (2*n*, 4*n*, 8*n*), of which the average DNA-content increases following a geometrical progression **2 : 4 : 8** (the average DNA-content of the lowest class (2*n*) doubling nearly that of the spermatozoa) were separated. In each of these classes the volumes of the spherical nuclei were easily calculated from their circular projection area. The average nuclear volumes for the three given classes follow exactly the same progression as the average DNA-content. Statistical computations of the results obtained in the liver of five normal rats, fixed (in alcohol 20 parts, formalin 15 parts, acetic acid 5 parts), embedded and stained by the Feulgen-reaction under the same conditions, are summarized in Table 1. It is shown that between the 'DNA-content-classes', 2*n* and 4*n*, not only the average DNA-content but also the average nuclear volume doubles. The 1 : 2 ratio becomes more precise with an increasing number of measurements (pooled results).

The scarceness of the nuclei of the 8*n* class (2–4 nuclei for 250 measurements) makes a statistical analysis difficult. However, it is evident that the volumes of those nuclei are ranged about the double of the average volume of the 4*n* class. From those results one could conclude that the 'DNA-content-classes' coincide with the 'nuclear-volume-classes'.

Within one of those classes the relationship between the DNA-content and the volume is not so evident for the different individual nuclei. From correlation diagrams obtained for the five livers studied, which we shall more extensively describe in another paper, one gets, however, the impression that such a relationship exists, at least to a certain extent. Although varying largely for each DNA-content value, the volume seems to present a mean value increasing with the DNA-content.

One might speculate that in the case of the rat liver the coinciding **2 : 4 : 8** ratios between the average volumes and between the average DNA-contents of the three nuclear classes depend on a common reduplicating factor (possibly polyploidy or polyteny), and within one class the DNA-content could be at least one factor acting upon the volume of individual

Table 1

Animals	Nuclear DNA-content class	Mean DNA-content of nuclei in arbitrary units			Mean nuclear volume in μ^3		
		n	$\bar{x} \pm s\bar{x}$	S	n	$\bar{x} \pm s\bar{x}$	S
224	2*n*	54	1,052·34 ± 16·7	122·7	54	116·7 ± 2·64	19·3
	4*n*	193	2,127·45 ± 15·9	221·8	193	223·2 ± 2·59	36·0
225	2*n*	57	1,003·20 ± 24·7	186·5	57	123·7 ± 5·80	44·0
	4*n*	188	2,071·70 ± 20·5	281·1	188	227·1 ± 2·96	40·6
226	2*n*	68	1,081·12 ± 16·0	132·5	68	105·9 ± 2·24	18·5
	4*n*	177	2,166·39 ± 20·2	269·4	177	233·2 ± 1·92	25·6
227	2*n*	83	1,044·36 ± 16·1	147·4	83	133·0 ± 3·03	27·3
	4*n*	167	2,089·51 ± 20·0	258·5	167	243·9 ± 2·55	32·9
228	2*n*	51	1,000·24 ± 18·9	135·0	51	108·1 ± 1·73	12·3
	4*n*	193	2,129·17 ± 18·9	263·4	193	226·3 ± 1·91	26·6
Pool	2*n*	313	1,038·25 ± 8·5	150·5	313	117·9 ± 1·61	28·4
	4*n*	918	2,116·04 ± 8·6	262·8	918	229·7 ± 1·12	34·1

n = Number of measurements; $\bar{x}$ = mean value; $s\bar{x}$ = deviation of the mean; S = standard deviation.

chromosomes and also indirectly upon the nuclear volume.

These investigations were carried out with a grant from the Fonds National de la Recherche Scientifique.

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Growth-promoting Activity for Pigs of Inactivated Penicillin

It has been shown by many workers that the regular administration of very small doses of most antibiotics, including penicillin, will significantly increase the rate of growth of many species of animals. Extensive investigation, however, has not clearly demonstrated the mechanism or mechanisms by which such a benefit is derived, although it is generally considered that the mode or modes of action are entirely dependent upon the antibacterial activity of the antibiotic employed[1]. It has been suggested, however, that autoclaved penicillin when given by daily injection, but not by mouth, will increase the growth-rate of chicks[2].

The results of two experiments reported here show that part of the benefit derived from a supplement of penicillin is due to one or more of its degradation products, probably the amino-acid penicillamine, and that inactivated penicillin, showing no antibacterial activity whatever, significantly increased the growth-rate of pigs, when given either by mouth or by injection.

The first experiment involved five groups of pigs, each group containing eight animals, which were maintained from weaning to 200 lb. live-weight. Procaine penicillin *G* was added to the diet at the rate of 15 gm. per ton of food, and groups receiving penicillin which had been inactivated by heat, by the action of penicillinase and by contact with heavy metals, were compared with a group receiving active penicillin, and a control group receiving no penicillin. It can be seen from Table 1 that each group receiving inactivated penicillin showed an increase in growth-rate and a reduction in food conversion ratio.

The second experiment compared active and inactive penicillin when given by mouth and by injection. The experiment was replicated twice and involved 120 pigs. The animals were maintained on the experiment from weaning until they reached 120 lb. live-weight and were fed a recommended ration[3]. Procaine penicillin was inactivated with penicillinase and was administered at the rate of 15 gm. per ton of food, or 0·5 mgm. per kilo body-weight daily by intramuscular injection. Both routes of administration supplied approximately the same total daily intake of antibiotics. It can be seen from Table 2 that in every case the inactive material produced an increase in growth-rate and a reduction in food conversion ratio, irrespective of the route of administration. In a comparable experiment, inactivated aureomycin hydrochloride was found to produce no growth response.

Table 1

Antibiotic	State	Growth-rate (lb./day)	Increase over control (per cent)		Food conversion ratio	Food saved (per cent)	
None	—	1·14	—		3·81	—	
Penicillin	Active	1·25	9·7		3·56	6·6	
Penicillin	Inactivated by heat	1·20	5·3	5·9	3·72	2·4	3·0
Penicillin	Inactivated by penicillinase	1·20	5·3		3·76	1·3	
Penicillin	Inactivated by salts of heavy metals	1·22	7·0		3·61	5·3	

Table 2

Antibiotic	State	Route of administration	Growth-rate (lb./day)	Increase over control (per cent)	Food conversion ratio	Food saved (per cent)
			First replicate			
None	—	—	0·91	—	3·11	—
Penicillin	Active	Oral	1·10	20·9	2·87	7·7
Penicillin	Inactive	Oral	1·04	14·3	3·03	2·6
None	—	—	0·85	—	3·28	—
Penicillin	Active	Parenteral	1·06	24·7	2·96	9·8
Penicillin	Inactive	Parenteral	0·98	15·3	2·99	8·8
			Second replicate			
None	—	—	1·01	—	4·20	—
Penicillin	Active	Oral	1·20	18·8	3·57	15·0
Penicillin	Inactive	Oral	1·17	15·8	3·71	11·7
None	—	—	1·07	—	4·03	—
Penicillin	Active	Parenteral	1·19	11·2	3·65	9·4
Penicillin	Inactive	Parenteral	1·13	5·6	3·67	8·9

Table 3

Experiment	Growth-rate (lb./day)			Food conversion ratio		
	Control	Active	Inactive	Control	Active	Inactive
1	1·14	1·25	1·21	3·81	3·56	3·70
2 (first replicate	0·88	1·08	1·01	3·19	2·92	3·01
2 (second replicate)	1·04	1·20	1·15	4·11	3·61	3·69
Mean increase over controls	—	14·3 per cent	9·4 per cent	—	9·2 per cent (food saved)	5·5 per cent (food saved)
Significance (deviation from controls)		$p<0·01$	$p<0·05$			

The results of both experiments are summarized in Table 3. Active penicillin produced a significant mean increase in growth-rate of 14·3 per cent, and inactive material produced a significant mean increase in growth-rate of 9·4 per cent. The inactive material thus produced 66 per cent of the growth response achieved with active penicillin. The difference between the effect of the active and inactive material was not significant.

The inactive material showed no activity *in vitro* against a range of test organisms, and no penicillin could be detected in the digestive tract, serum or urine of animals receiving the inactivated material. It seems likely that the only relatively stable end-product common to each of the three methods of inactivation employed is the thiol amino-acid peni-

cillamine (E. L. Smith, personal communication), which has already been shown to be capable of increasing the growth-rate of chicks when given by daily injection[4]. Further work is being undertaken elsewhere to evaluate the nutritional significance of this material.

We are grateful to Dr. R. C. Campbell for statistical analysis of the experimental results, to Mr. R. Long of Glaxo Laboratories, Ltd., for preparation of the inactivated penicillin, and to Glaxo Laboratories, Ltd., for supplying the penicillin used in these experiments.

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A New Rare Blood-Group Antigen, *Chr*^{a}

During recent years, many rare blood-group antigens, so-called 'private' or 'family' antigens, have been discovered. A survey of eleven of these was recently made by van Loghem and his associates, who described two new antigens. Most of the antigens were found exclusively in the members of one family; but as suggested by Dunsford, who studied the Wright system, some of these antigens may be ordinary blood-group factors with a very low frequency. Most of the corresponding antibodies were the results of iso-immunization during pregnancy or by blood transfusion, but a few of them were naturally occurring antibodies.

Through routine screening for blood-group antibodies we found a hitherto unknown antibody, which at 37° C. agglutinated trypsinized red cells from one of the test-cell donors, who happened to be the present writer. The serum donor was a nineteen-year-old unmarried woman, who had never received transfusions and had never been pregnant. Serological investigations showed that the antibody was most active in albumin at 37° (titre 8). It was less active in saline and by the trypsin technique, and it gave no reaction by the indirect Coombs technique. The antibody was weakly active at 20°. The test serum has since been tested against the red cells from 311 persons selected at random; but so far it has been found to react with the red cells from only one more person.

Investigations of the blood-group genotypes of the test-serum donor and of the two persons whose red cells had reacted with the test serum gave the following results:

B. Chr. (test-serum donor): *A, CDe/c e, MNs, Le(a+), P, k/k.*

F. K.-N.: *O cde/cde, MNs, Le(a−), P, k/k, Lu(a−), Fy(a−), Jk(a+).*

S. S.: *O cde/cde, MNs, K, Le(a−), p/p.*

Studies of the families of F. K.-N. and S. S. have not revealed other persons giving positive reactions with the test serum; but unfortunately it has been impossible to draw any conclusions concerning inheritance from the results obtained in the available family material. Seven relatives of F. K.-N., including two brothers, one sister and the mother, and three relatives of S. S., two brothers and one sister, have been investigated.

The test serum has been investigated by Miss Mia van der Hart and Dr. J. J. van Loghem, who found that the antibody was different from antibodies reacting with the following 'private' blood-group antigens: *Vw* (Verweyst), *Rm* (Romunde) and *Vis* (Wright). Testing against 150 blood samples chosen at random gave negative results. The test serum was also investigated by Dr. A. E. Mourant, of the Lister Institute, London. He stated that the antiserum was not identical with those from Berrens, Graydon, Wright and two other 'family' antisera which are as yet unpublished. Dr. E. Freiesleben has tested the serum against thirty-nine random blood samples, also with negative results. Thus, including my own investigations, the serum has been tested against a total of five hundred random blood samples, of which only two gave positive reactions, which gives a frequency of 0·4 per cent. The antibody has been named anti-*Chr*^{a} on the supposition that an anti-*Chr*^{b} reacting with a very common blood-group antigen may exist.

I wish to thank Dr. A. E. Mourant and Dr. Dorothy M. Parkin, of the Lister Institute, London, Miss Mia van der Hart and Dr. J. J. van Loghem, Amsterdam, and Dr. E. Freiesleben, of Statens Seruminstitut, Copenhagen, who all assisted me in the serological investigations.

This work was aided by grants from the Anders Hasselbalch Anti-Leukæmia Foundation and C. P. Schepler and Wife's Bequest, the Irma Foundation.

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Some Notably High Acuities of Taste for Phenylthiocarbamide

In the course of a recent study of the thresholds of taste for phenylthiocarbamide (phenylthiourea) of members of a division of the Malayan Negritos, some extraordinarily high acuities were encountered.

The Negritos under study belonged to the Kintak Bong division, most of the few remaining members of which are at present living in the Baling district of the State of Kedah, Federation of Malaya. They are probably the 'purest' of the Negritos still living in the Malay Peninsula. The phenylthiocarbamide solutions employed in the work comprised a series numbered 0, 1, 2, . . . 18, the concentration of the substance being $2{\cdot}60 \times 2^{-n}$ gm. per litre, where n is the solution number.

Three of the youths, aged seventeen, eighteen and fifteen years, were able successfully to distinguish in sorting trials between the solvent (distilled water) and solutions numbered 18, 17 and 16, respectively, the chance of success by guesswork being 0·125 in each case. Assuming that guesswork actually played

no part in the trials, we may accept the respective solution as having set an upper limit to the threshold concentration in each case. These concentrations are lower than the lowest that appear to have been used by other workers elsewhere[1–3], and I wish to direct attention to the high acuities of taste for phenylthiocarbamide possessed by these subjects, the first-mentioned in particular.

Bitterness appears to be the taste sensation most readily evoked by appropriate substances, of which brucine, strychnine and quinine are among the most potent, brucine being accepted (apparently) as the most potent known and, on a weight basis, some twelve times more effective than quinine and four times more effective than strychnine[4]. Thresholds for quinine have been investigated fairly extensively. Recent upper-limit values obtained by Harris and Kalmus[2] for thirty-eight subjects range from $2{\cdot}4 \times 10^{-4}$ to $5{\cdot}7 \times 10^{-6}$ molar, calculated as quinine from the quinine sulphate (anhydrous ?) they used, and were obtained by sorting trials requiring discrimination between solvent and solution. Moncrieff[4] has discussed results varying from 4×10^{-5} to $1{\cdot}5 \times 10^{-6}$ molar. A result reported by Kiesow[5] (quoted by Fulton[6]) corresponds with $1{\cdot}3 \times 10^{-6}$ molar quinine solution, calculated from the quinine sulphate (dihydrate ?) employed. A value, $1{\cdot}5 \times 10^{-7}$ molar, quoted by Dethier and Chadwick[7] and by Jahn and Wulff[8], appears to have arisen from a mistake in calculation. Thus, $1{\cdot}3 \times 10^{-6}$ molar appears to be the lowest recorded threshold concentration for quinine and, on the basis of the weight ratios mentioned above, a threshold concentration of 1×10^{-7} molar might be expected for a very acute taster of brucine.

Phenylthiocarbamide belongs to a group of substances the threshold concentration of each of which covers a very wide range in a human population and is distributed bimodally. It is normally classed as 'bitter'; but it is well known that in the neighbourhood of their thresholds subjects may be inclined to characterize the taste as other than bitter, though usually describing it as 'bitter' at somewhat higher concentrations. Thus, the first-mentioned subject described the taste of solution 18 as 'sour', as did the second describe the taste of solution 17, and the third the taste of solution 16. The third described the taste of solution 14 as 'bitter and sweet'.

As the concentration of solution 18 is 9·9 μgm. of phenylthiocarbamide per litre, namely, $6{\cdot}5 \times 10^{-8}$ molar, the first-mentioned subject seems to enjoy the distinction of possessing for phenylthiocarbamide a higher acuity of taste than has been recorded for any other subject tasting any substance.

The volume of solution transferred to these subjects' mouths for tasting purposes was only 2·5 ml. on any one occasion. It contained, therefore, in the particular case under discussion, only 0·025 μgm. of phenylthiocarbamide (namely, $1{\cdot}6 \times 10^{-12}$ mole or about 4×10^{11} molecules), and it is unlikely that even all this small amount was involved in reactions at the taste-buds. If Moncrieff's[4] estimate, that 0·05 ml. of solution properly applied should be sufficient for taste-testing, is correct, then this subject may have been able to detect a quantity of phenylthiocarbamide as minute as 8×10^9 molecules.

In passing, it is of interest to record that, in contradistinction to this high acuity, two female members of the same ethnic group were unable to distinguish even solution 0 from the solvent. It is the widest range of acuities we have encountered in any of the six Malaya-domiciled ethnic groups that we have examined.

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A New Form of Male Sterility in *Nicotiana tabacum* L.

Male sterility in tobacco has been reported previously by Clayton[1] in advanced back-cross generations of two interspecific crosses between *Nicotiana debneyi* and *N. megalosiphon* as female parents, and *N. tabacum* as pollen parent. He suggested that the cause may be incompatibility

Fig. 1. Normal anthers observed in variety American Joiner and first-generation progeny of the new male sterile form (*a*) are compared with types of dissected flowers of the new male sterile form (*b*), individual petaloid stamens of the new male sterile form (*c*), and a dissected flower of variety Male Sterile 402 (*d*). The latter was derived from an *N. debneyi* × *N. tabacum* hybrid and generally contains one or more aborted stamens which may be fused in groups of two or more or with the stigma

between the cytoplasmic constituents of the former and the nuclear constituents of the latter.

A new form of male sterility was observed here during the 1953–54 season, which may be conditioned by genetic rather than cytoplasmic factors. It appeared spontaneously in plants of flue-cured variety American Joiner grown from seed several years old. Plants from the same seed this current season again exhibited one male sterile to about twelve normal plants. Male sterile flowers are characterized by petalody of the stamens, slightly reduced corolla size and lighter coloration (see Fig. 1). Even where rudimentary anther-like structures were present, no pollen was detected. In a small proportion of flowers the corolla was four-lobed and accompanied by four aborted stamens.

This new male sterile form was crossed with normal plants of American Joiner, and the F_1 generation produced only normal fertile flowers. A study of the mode of inheritance and possible linkage relationships has been initiated.

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Size Variations of Septate Wood Fibres in *Pithecolobium dulce* Benth.

In a recent abstract, Spackman and Swamy[1] state that septate wood fibres "exhibit considerable variation in size, structure and contents. In most instances these elements are considerably longer than the cambial initials from which they were derived. In some forms, however, the elongation has been slight and in others no elongation has taken place and the elements are essentially cambiform". It is needless to say that the above statements were of a casual nature and were not substantiated by actual demonstration.

The septate fibre is an unusual cell type in two important ways. First, it illustrates that lignification is not a necessary concomitant of the death of the protoplast, but that the protoplast continues to exhibit dynamic activities even after the complete lignification of the secondary wall. Secondly, this is a cell type modified to perform a dual function, namely, affording mechanical strength, on which the function of storage has become superimposed. The available information on the origin, distribution and behaviour of this important category of cells of the secondary xylem is admittedly meagre.

Exploratory investigations indicate that this cell type occurs sporadically in many (about a hundred) of the dicotyledonous families and that the proportion of this cell type to others of the secondary xylem is variable not only among genera and species but also within a single individual. There are also instances where the septate fibres are confined only to a particular sector of the stem or branch, or occur only in the early or later formed parts of the secondary xylem. Much more extensive and intensive investigations on this remarkable cell type are necessary in order to understand clearly its exact morphological and functional features.

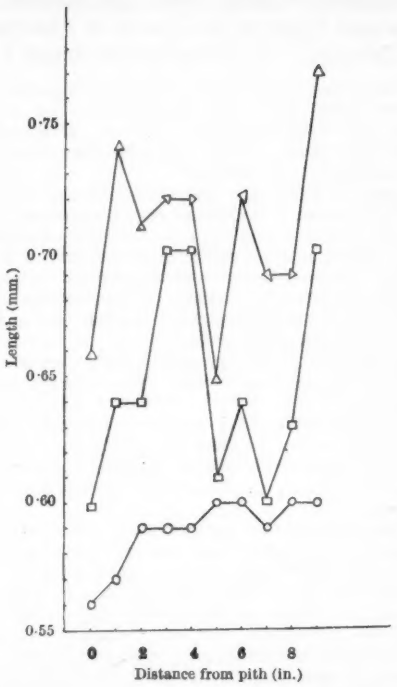

Fig. 1. Length-on-age curves illustrating variations of vessels (bottom), non-septate (middle) and septate fibres (top)

In *Pithecolobium dulce* Benth., the septate fibres are intermixed with the non-septate ones throughout the secondary xylem. A disk of 9-in. radius from two feet above ground-level was available for investigation. Measurements of tracheal elements were taken at every successive inch from the centre along the radius, and the data thus obtained were statistically analysed. The results may be summarized as follows (Fig. 1): The vessel members show a gradual increase in length in the early stages (until the second inch from the centre), but afterwards their length is subject to very little fluctuation. The non-septate fibres as well as the septate fibres in the early stages behave in a manner similar to the vessels in regard to their linear dimensions; but later their length is subject to considerable variations. The most remarkable feature that has emerged from the present study concerns the total independence of the septate and non-septate fibres in regard to their respective linear dimensions. The length-on-age curves for these two cell types are more or less parallel. However, it is significant that the septate fibres are not only longer than the non-septate ones from the initial stages, but also that the same relative linear values are maintained throughout ontogeny.

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An Apparent Change from Cytoplasmic to Nuclear Control of a Form of Chlorophyll Deficiency in *Gossypium arboreum* L.

The occasional occurrence of variegated plants in *Gossypium herbaceum* race *Wightianum* has been reported by Gopalratnam[1], and in *Gossypium arboreum* race *sinense* by Feng[2], who also reported typical maternal inheritance.

Variegated plants have frequently been observed at this Institute in *G. arboreum* race *bengalense*. On one of these plants a bud from a chlorophyll-deficient area was forced into growth by appropriate pruning, giving rise to two flowers with chlorophyll-deficient boll, calyx, bracts and pedicel. These two flowers were selfed and the pollen also used for pollinating several types of normal green.

Selfing resulted in two progenies with twelve and thirteen yellow seedlings which died shortly after germination.

The crosses of normal green × deficient gave sixteen plants all of which were green.

From the sixteen F_1 plants, sixteen F_2 families were raised. The F_2 families exhibited two types of behaviour.

(1) *Normal Mendelian segregation.* Family *B*6 gave eighty-six plants of which sixty-seven were green and nineteen yellow deficient—a close approximation to the usual 3 : 1 ratio. The results of F_3, F_4 and F_5 confirmed the mode of inheritance as monogenic. Chlorophyll deficiency, however, showed a progressive increase in viability, and in F_3 and subsequent generations it was possible to grow deficient plants to maturity. They flowered well in pots, the first year's growth producing yellow-green leaves, while the leaves in the second year were almost full green, with only the growing-point yellow-green. Crosses were then made reciprocally between the new type of viable deficient and normal green. In F_1 green was fully dominant with 3 : 1 segregation of green to deficient in F_2, thus : green × deficient, 80 : 19 ; deficient × green, 108 : 29. A slight excess of green plants is found.

(2) *Maternal inheritance.* The F_2 families from the other fifteen crosses threw only greens—a total of 1,879 plants being recorded. This absence of segregation conforms to the usual type of cytoplasmically determined inheritance.

Therefore, out of sixteen crosses between female green and male chlorophyll-deficient from a deficient region of a variegated cotton plant, fifteen exhibited maternal (cytoplasmic) inheritance, while in the remaining family inheritance was nuclear and monogenic, with mutation from green to deficient in one locus as a possible explanation. This transition from cytoplasmic to nuclear control has apparently not been recorded in other plants. The improvement in viability of deficients from lethality to the condition of fertility is possibly due to progressive reverse plastid mutation.

I am indebted to Prof. S. C. Harland for his help in writing this communication, and to Mr. R. B. Sethi, director of the Indore Institute of Plant Industry, for permission to publish it.

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Synthesis and Properties of S-Alanyl Coenzyme *A*

S-alanyl coenzyme *A* has been prepared by aqueous transfer of the alanyl residue from S-alanyl thiophenol hydrochloride to coenzyme *A* (Co*A*—SH), in a manner similar to that used for the synthesis of S-alanyl glutathione[1], and other S-acyl compounds[2–4] :

$$PhSCOCH(CH_3)NH_3^+Cl^- + CoA—SH \rightarrow PhSH + CoA—SCOCH(CH_3)NH_3^+Cl^-$$

Due to the small quantities of Co*A*—SH available and the lability of S-alanyl coenzyme *A*, the product could not be isolated by classical methods, that is, as a metal salt. However, S-alanyl coenzyme *A* was successfully isolated in the pure state by paper electrophoresis (50 V./cm.), as it migrates at a slower rate than Co*A*—SH.

50 mgm. (70 per cent pure) Co*A*—SH and 25 mgm. of S-alanyl thiophenol hydrochloride were dissolved in 0·2 ml. of water. The *p*H of the solution was adjusted to 5–6 by means of the dropwise addition of 2 *N* sodium hydroxide solution. The reaction solution was then placed in a cold room at 4° C. for three days. The product was separated and purified by paper electrophoresis in a neutral buffer (pyridine : acetic acid : water, 10 : 1 : 89). (It was found necessary to use several 35-cm. wide paper sheets, owing to the low capacity of the paper.) The buffer solution was removed from the electropherogram by freeze-drying, and the area which contained S-alanyl coenzyme *A* was cut out and eluted at low temperature with water. The water solution of S-alanyl coenzyme *A* was then freeze-dried. The yield was 20 mgm.

A fresh solution of S-alanyl coenzyme *A*, subjected to paper electrophoresis, exhibited one identical spot when developed with ninhydrin, in ultra-violet light, and with nitroprusside ammonia. The nitroprusside spot was slightly delayed, appearing within 1–2 min. The paper electropherogram of an aged solution also contained a positive ninhydrin spot for alanine.

When a sample of S-alanyl coenzyme *A* was incubated for 2–3 hr. with an excess of glutamic acid at *p*H 8 in a sodium bicarbonate buffer solution at 20° C., a new ninhydrin reactive compound arose. This compound we believe to be alanyl-glutamic acid (Fig. 1). In the presence of pigeon-liver homogenate,

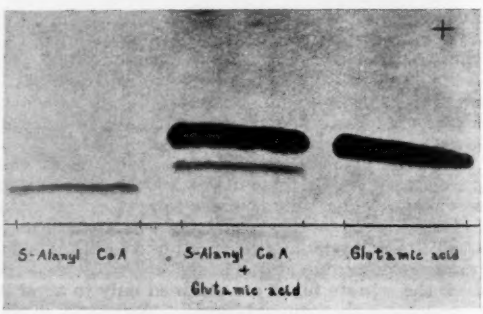

Fig. 1. Electropherogram of S-alanyl coenzyme *A* – glutamic acid incubation mixture. The formation of alanyl-glutamic acid is shown in the middle column where it has migrated at a slower rate than glutamic acid (right column), but faster than S-alanyl coenzyme *A* (left column). Composition of incubation mixture : 0·1 ml. of 0·5 *M* sodium bicarbonate, 0·05 ml. of 0·1 *M* glutamic acid, 0·05 ml. of 2 mgm./ml. S-alanyl coenzyme *A*

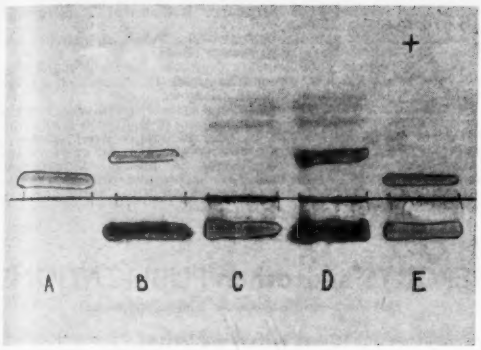

Fig. 2. Action of S-alanyl coenzyme *A* deacylase. *A*, S-alanyl coenzyme *A*; *B*, S-alanyl glutathione, lower spot (traces glutathione upper spot); *C*, S-alanyl coenzyme *A* + deacylase, spot: alanine; *D*, S-alanyl glutathione + S-alanyl coenzyme *A* deacylase; *E*, S-alanyl coenzyme *A* + glyoxalase II. Composition of incubation mixtures: 0·05 ml. Sörensen phosphate buffer *p*H 5·4, 0·05 ml. enzyme solution, 0·05 S-alanyl compound (2 mgm./ml.). Time, 15 min. at 20° C.

a rapid enzymatic hydrolysis of S-alanyl coenzyme *A* to alanine and Co*A*—SH takes place. The active deacylase is not identical with glyoxalase II [5]. A pure sample of glyoxalase II rapidly cleaves S-alanyl glutathione[1]; however, it does not, or only very slowly, hydrolyse S-alanyl coenzyme *A* (Fig. 2).

S-Alanyl coenzyme *A* deacylase is present mainly in the mitochondria and microsome fractions of liver. However, it is also present in smaller concentration in the plasma fraction of the liver homogenate.

Attempts to demonstrate an enzymatic acyl transfer of the alanyl group to other amino-acids or to the SH group of cysteine have been unsuccessful thus far, because of the rapid, possibly competing, enzymatic hydrolysis of S-alanyl coenzyme *A*.

Coenzyme *A* was kindly given to us for experimental purposes by C. H. Boehringer Sohn, Ingelheim.

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Meaning of 'Turnover' in Biochemistry

IN a recent communication, Kleiber[1] has discussed two different definitions of the term 'turnover-rate'. Some workers, particularly those associated with Chaikoff, regard the turnover-rate as the rate at which a substance is replaced in the tissue cells (definition 1). This is essentially the concentration of the substance in the tissue divided by the turnover-time. Others, including Kleiber, consider it to be the rate at which the whole 'pool' of the substance, however large or small, is replaced in the tissue, given by the reciprocal of the turnover-time (definition 2). Both groups agree that the turnover-time is the biological 'average life', given by 1·44 × biological half-life.

These concepts are each valuable; but the turnover-rate as defined by Kleiber tells no more about physiological events than does the turnover-time. Two tissues could have the same turnover-time and yet contain very different concentrations of the substance under consideration. They would have the same turnover-rate according to Kleiber, yet unit weight of the one tissue would metabolize the substance much more rapidly than unit weight of the other.

The dorsolateral prostate of the rat contains more than ten times as much zinc as the ventral prostate[2] per unit weight. The results of turnover experiments with these tissues, using zinc-65, are given in Table 1. The data are taken from a paper which is being prepared in collaboration with Miss M. I. Fischer and Dr. B. E. Riedel. The turnover-rate of zinc in the dorsolateral prostate is nearly ten times as great as in the ventral prostate according to definition 1; but by definition 2 the turnover-rate of the ventral prostate is actually greater than that of the dorsolateral prostate.

Table 1. TURNOVER OF ZINC IN THE PROSTATE GLANDS OF THE RAT

	Ventral prostate	Dorsolateral prostate
Mean zinc content (μgm./gm.)	13·5	168
Biological half-life ($T_{1/2}$) (days)	7·6	9·9
Turnover-time ($T_{1/2}$ × 1·44) (days)	10·9	14·3
Turnover-rate (1)* (μgm. Zn/gm./day)	1·24	11·8
Turnover-rate (2)* (fraction of pool/day)	0·092	0·064

* Turnover-rate (1) = μgm. Zn/gm. tissue divided by turnover-time. Turnover-rate (2) = reciprocal of turnover-time.

Many tracer experiments are done without estimation of the concentration of the substance under investigation, and this applies particularly to work with trace elements, especially those which do not occur naturally in the body in measurable amounts. It may partly be for this reason that most workers have defined turnover-rate as the reciprocal of turnover-time. However, the Chaikoff concept of turnover-rate is of such physiological significance that it should have a name. In Table 1, turnover-rate (1) could be described as the zinc turnover-rate, and (2) as the zinc pool turnover-rate; but these terms are sufficiently similar to lead to confusion. It is suggested that the Chaikoff turnover-rate (1) should be called the flux-rate, retaining 'turnover-rate' for the definition favoured by Kleiber. The word 'flux' has been used in a similar sense by Reiner[3] in a theoretical discussion of the implications of turnover-rate calculations.

Zilversmit[4] has suggested that 'turnover-rate' should continue to apply to definition 1, and has proposed an alternative term for definition 2. I believe that this would be a mistake. An extensive review of the literature has shown that 'turnover-rate' is defined according to definition 2 in the great majority of cases and any alteration would add to the confusion which we all wish to avoid.

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APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

ASSISTANT EXPERIMENTAL OFFICER (with a pass degree or at least G.C.E. at advanced level) IN THE PLANT BREEDING SECTION—The Secretary, National Vegetable Research Station, Wellesbourne, Warwick (August 17).

SENIOR PSYCHOLOGIST IN THE DEPARTMENT OF PSYCHOLOGICAL MEDICINE, to be responsible for the diagnostic testing of adults and children—The Clerk to the Governors, St. Thomas's Hospital, London, S.E.1 (August 17).

LECTURER IN GEOLOGY, with special reference to petrology—Head of the Department of Geology, Imperial College of Science and Technology, Prince Consort Road, London, S.W.7 (August 19).

EXPERIMENTAL OFFICERS and ASSISTANT EXPERIMENTAL OFFICERS (with at least H.S.C. (science) or equivalent), at the Ministry of Supply National Gas Turbine Establishment, near Farnborough, Hants, for work concerned with problems of combustion, heat transfer, aerodynamics, projects and performance instrumentation and application of electronics in gas turbine research—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting C.146/5A (August 27).

RESEARCH DEMONSTRATOR IN PHYSICS—The Registrar, The University, Sheffield (August 27).

ASSISTANT IN NATURAL HISTORY—The Secretary, The University, Aberdeen (August 31).

DIRECTOR OF THE UNIVERSITY GARDENS at Ness, Neston, Wirral—The Registrar, The University, Liverpool (August 31).

RESEARCH ASSISTANT IN THE PHYSICS DEPARTMENT, for work with Prof. K. G. Emeléus either in spectroscopy or on gaseous conductors—The Secretary, Queen's University, Belfast (August 31).

RESEARCH ASSISTANT (with a degree in physics and preferably with some research experience) IN THE DEPARTMENT OF PHYSICS, to undertake wave-length measurements of high precision, using a reflecting echelon interferometer—The Registrar, King's College, Newcastle-upon-Tyne (August 31).

RESEARCH FELLOW IN MATHEMATICAL PHYSICS at the University of Adelaide, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Adelaide, August 31).

LECTURER IN COMPARATIVE SOCIAL ADMINISTRATION at Victoria University College (University of New Zealand)—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (New Zealand, September 1).

ASSISTANT LECTURER OR LECTURER IN THE DEPARTMENT OF PHARMACOLOGY AND THERAPEUTICS—The Registrar, The University, Liverpool (September 3).

ASSISTANT LECTURER IN METALLURGY—The Registrar, The University, Manchester 13 (September 7).

LECTURER IN THE DEPARTMENT OF BOTANY at the University of New England, Armidale, New South Wales, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, September 12).

PROFESSOR OF GENETICS—The Registrar, University of Adelaide, South Australia (September 15).

READER IN MECHANICAL ENGINEERING at the University of Hong Kong—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Hong Kong, September 15).

LECTURER (first-class honours graduate in mathematics, and preferably with special interests in some branch of applied mathematics or statistics) IN MATHEMATICS—The Registrar, College of Technology, Manchester 1 (September 19).

LECTURER IN GEOLOGY at the University of Tasmania—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Tasmania, September 30).

SENIOR LECTURER IN BIOCHEMISTRY at Victoria University College, Wellington, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (New Zealand, September 30).

ASSISTANT LECTURER (honours graduate in chemistry, with research experience and special interests in physical or inorganic chemistry) IN CHEMISTRY—The Registrar, College of Technology, Manchester 1 (October 1).

LECTURER (with experience in some of the following subjects: X-ray crystallography, non-destructive testing, optical methods of examination, gauging methods and instrumentation of plant) IN INDUSTRIAL METALLURGY—The Registrar, The University, Birmingham 15 (October 15).

ASSISTANT BIOCHEMIST (Basic grade) (with a B.Sc. degree with honours in chemistry or biochemistry, or an equivalent qualification) IN THE DEPARTMENT OF PATHOLOGY—The Group Secretary, The Royal Hospital, Wolverhampton.

BIOCHEMIST (with an honours degree in chemistry or biochemistry, and with one or two years biochemical research experience), to assist in research work in the Special Unit for Juvenile Rheumatism—The Secretary, Canadian Red Cross Memorial Hospital, Taplow, near Maidenhead.

CHEMICAL ENGINEERS AND CHEMISTS (with an honours degree in chemistry or chemical engineering, or corporate membership of a relevant recognized professional institution or equivalent qualifications) to work in a group concerned with the industrial aspects of atomic energy—The Recruitment Officer, United Kingdom Atomic Energy Authority, Research and Development Branch, Industrial Group Headquarters, Risley, near Warrington, quoting Ref. 1,057.

CIRCUIT ENGINEER (with a knowledge of pulse techniques and video and r.f. amplifiers, and a recognized technical qualification) IN THE NUCLEAR PHYSICS RESEARCH LABORATORY to work on design of electronic equipment associated with the experimental programme of the 156 in. synchrocyclotron—The Registrar, The University, Liverpool, quoting Ref. No. 220.

EXPERIMENTAL OFFICER or ASSISTANT EXPERIMENTAL OFFICER (with a degree in geology, chemistry or physics), for work on the X-ray and differential thermal examination of clays (Soil Survey of England and Wales)—The Secretary, Rothamsted Experimental Station, Harpenden, Herts.

LECTURER IN ANIMAL HUSBANDRY—The Principal, Shuttleworth College, Old Warden Park, Biggleswade, Beds.

LECTURER (with a good honours degree in electrical engineering and with experience in servomechanisms) IN ELECTRONICS—The Secretary, Royal Technical College, Glasgow.

PRINCIPAL SCIENTIFIC OFFICER (with a first- or second-class honours degree or equivalent in mathematics, physics or engineering, and with instrument experience), at the Ministry of Supply Headquarters in London, to be in charge of a section responsible for research and development of fire-control equipment for military aircraft and ancillary equipment—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.275/5A.

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